The UTILIZATION OF OUR LANDS FOR CROPS, PASTURE AND FORESTS

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THE DOMINANT characteristic of American economic life has been abundance of land resources. The assumption of this abundance has colored our habits of thought and become the essential foundation for our economic policy, both individual and public. This national tradition was first seriously challenged by the conservation movement, which caused our people to pause and consider whether our amazing population growth and two centuries of exploitation of natural resources might have altered the outlook. However, that movement directed attention principally to the forests, mineral resources, and water powers, whereas the object of this article is to consider our present situation and future outlook in regard to our resources available for growing the food and raw materials that must be supplied by our crop lands, pastures, and forests.[1]

This will involve (1) a summary of our present land resources and of the extent and character of present uses, and (2) an estimate of future requirements—particularly those of the next few decades—and the relation of these requirements to the potential area available for the various uses.

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[1] This article grew out of the work of the Land Utilization Committee appointed by the Secretary of Agriculture in 1921. The contribution of C. V. Piper, Bureau of Plant Industry, a member of this committee, has been included in the preceding article, "Our Forage Resources." S. J. McCrory, Bureau of Public Roads, a member of the committee, provided much of the basic data for the map of wet lands (fig. 8), and C. F. Marbut, Bureau of Soils, much of the basic data for the map of forest and cut-over land available for crops without drainage (fig 9) and for the map of land physically suitable for forest only (fig. 13). Suggestions concerning the economic value of wild life as a consideration in land utilization were made by W. L. McAtee, Biological Survey. L. C. Gray, Chairman of the Committee, was in general charge of the preparation of this article. Many of the estimates of land area were made by O. E. Baker, who acted as secretary to the committee. Dr. Sewell Wright, Bureau of Animal Industry, who was not, however, a member of the committee, prepared the maps in this article showing the quantity of livestock by counties, 1850–1920 (figs. 22 to 29); C. W. Warburton, Director of Extension Work, contributed to the discussion of the means of increasing crop yields; and W. N. Sparhawk, Forest Service, furnished valuable assistance in checking the various estimates.

The three principal agricultural uses of the land are for crops, for pasture, and for forest. It is important to consider these three uses jointly, because they are partly competitive and partly complementary in their land requirements. Thus, a large part of the humid land of the United States is physically capable of being employed for each of these three uses. The arid or semiarid land is

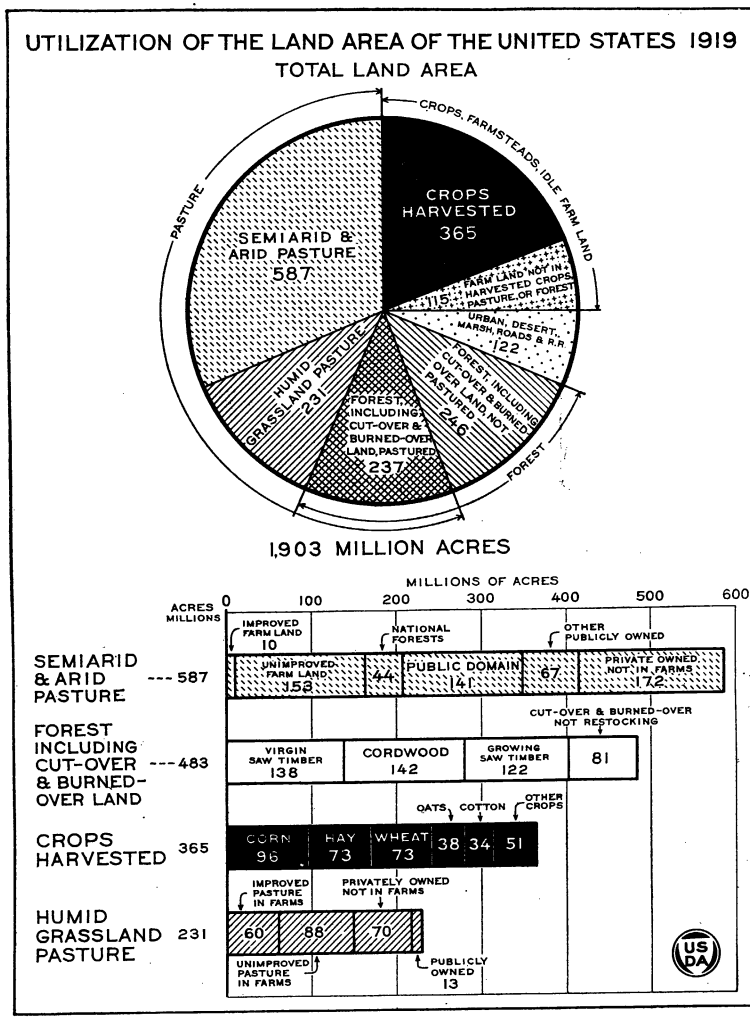

FIG. 1.—Crops harvested in 1919 occupied 19 per cent of the land area of the United States. Pasture (excluding both temporary crop pasture and forest land used incidentally for pasture) occupied 43 per cent, and forest and cut-over land about 25 per cent of the total area. However, the fifth of the land area in crops yielded a vastly greater annual product measured by value than the two-thirds in pasture and forest. The remaining 13 per cent of the land area was almost equally divided between land in farms not used for crops, pasture, or forest (mostly crop land lying idle, crop failure farmsteads, lanes, and waste areas), and nonagricultural land outside farms (mostly urban land, absolute desert, rocky areas, and land used for roads and railroads). Many of the figures in the graph are estimates.

not suitable for growing forests,[2] but nearly all of it may be employed for grazing; and the portions where rainfall, topography, and soil are suitable, may be used for crops. Again, the three uses are in part complementary, for much of our forest lands may be used at the same time for grazing, and our crop land may generally be improved by including pasture in the crop rotation. Furthermore, crops and pasture are alternative sources of feed for livestock.

Present Uses of Our Land Resources.

No attempt at a complete economic classification of the land area of the United States has ever been made. Consequently, in the following discussion it has been necessary to rely largely on estimates made by the writers of this article.[3]

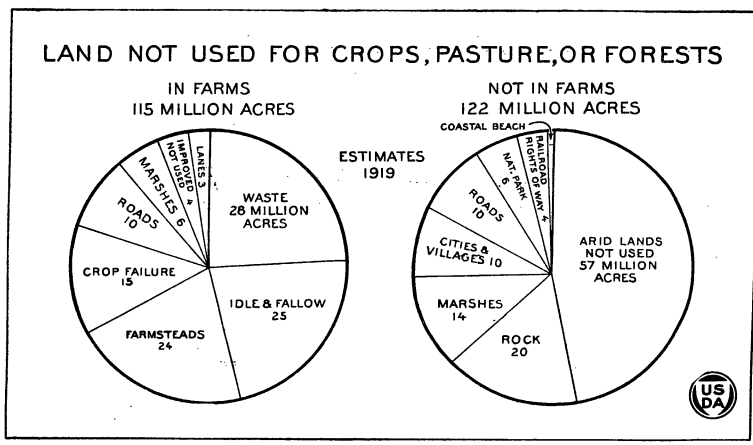

FIG. 2.—The total area shown by the two circles as not at present employed for crops harvested in 1919, pastures or forests is 237,000,000 acres, almost equally divided between land in farms and land not in farms. It should be noted, however, that the items under land in farms includes an estimated 15,000,000 acres of crop failure in 1919, which was a very dry year in the spring-wheat region of the Northwest, and an estimated 25,000,000 acres of crop land lying idle or fallow. If these 40,000,000 acres are subtracted there remain only 75,000,000 acres of land in farms not used for crops, pasture, or forests. The 6,000,000 acres of national parks include about 3,000,000 acres of forest, which is not utilized as such. Of the entire 237,000,000 acres of such land in farms and not in farms it is estimated that about one-half is physically capable of use in the future for crops, pasture, or forest.

The estimated division of our total land area of approximately 1,903,000,000 acres,[4] from the standpoint of the present uses of the surface, is summarized in Figure 1.

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[2] In certain parts of the semiarid territory scrubby forests of mesquite and live oaks, or of piñon pine and juniper occur. This arid woodland may be of considerable value in supplying fence posts and fuel. Also along the borders of streams, species characteristic of humid regions are found.

[3] These estimates are derived as far as possible from calculations based on census statistics, on reports and maps prepared by the Soil Survey and the Forest Service, and on the field notes and plats in the General Land Office. These materials were supplemented by information obtained from various sources, especially the Division of Agricultural Engineering (Drainage Investigations), of the Bureau of Public Roads, the Geological Survey, and various State surveys. More complete data have made necessary changes in certain rough estimates previously issued of the present and potential uses of land.

[4] The land area of the United States is 1,903,289,000 acres. In the following discussion the round number is used, and the various estimated subdivisions of the entire are are made to total 1,903,000,000.

Land Not Used for Crops, Pasture, or Forest.

It will be noted that, of the total area, only about 237,000,000 acres, or a little over 12 per cent, are not already in use for crops, pasture, or forest (fig. 2). More than half of this land, about 122,000,000 acres, is outside the boundaries of farms, while about 115,000,000 acres are land in farms not employed at present for any of the three uses mentioned. However, this last includes an estimate of 15,000,000 acres of crop land not harvested, because of crop failure, and an estimate of 25,000,000 acres of crop land idle or fallow.[5]

Of the 237,000,000 acres not used at present for harvested crops, pasture, or forest, it is estimated that less than one-half may some time be employed for one or more of these purposes, leaving 134,000,000 acres that can not be employed for crops, grazing, or forests in the future, either because devoted to other uses or because physically unsuitable.[6]

Thus, it appears that there is an area of less than 1,800,000,000 acres (1,769,000,000) capable of being used for either crops, pasture, or forest, although for part of it some form of reclamation would be necessary. Ultimately, of course, the increase of population will require the employment of somewhat larger areas of land for cities and villages, roads, and farmsteads. When the maximum population of the Nation is attained, it is probable that about 35,000,000 acres more may be needed for these uses, reducing

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[5] The various classes of land outside the boundaries of farms and not employed for crops, pasture, or forest were estimated as follows: City area was estimated by finding the density per square mile for a number of representative cities for which the area was known, classifying these by size, and then dividing the factor of density into the population living in incorporated places of each class. The estimates were made by States. Area in public roads was estimated by multiplying the mileage of various classes of roads in each State by estimates of average width of these roads supplied by the Bureau of Public Roads. Since the estimates were obtained as of 1914, about 2,500,000 acres were added for increase in the area devoted to public roads. In reporting the area of farms to census enumerators, farmers living in the regions where the rectilinear system of survey prevails frequently give the total area originally in the tract without making deduction for the area devoted to public roads. Thus, a 160-acre farm from which a portion was subtracted for roads is very commonly still reported as 160 acres. On this account, the estimate of 20,000,000 acres in public roads was arbitrarily divided equally between the area in farms and the area not in farms. The area in farms is less than the area not in farms, but it contains a much larger proportion of the roads. The area of unused desert land is a rough estimate, based on such information as could be obtained in the Department of Agriculture and from the Land Classification Board of the United States Geological Survey. The area of rocky peaks and rock outcrop is merely a rough estimate based on the ruggedness of the country. The area of coastal and interior marshes not pastured or cut for hay and not in farms is computed from soil survey maps, topographic sheets, coast survey charts, etc., and includes 7,500,000 acres in tidal marshes and 6,500,000 acres in sweetwater marshes. The estimate of 1,000,000 acres of coastal beaches is derived from the same sources. The area of national parks is an official figure, and the area of railroad rights of way was obtained by multiplying the railroad mileage, courteously provided by the Interstate Commerce Commission, by an estimated average width of the rights of way.

The various items included in the 115,000,000 acres of land in farms not used for crops, pasture, or forests were estimated as follows: Various local surveys have indicated that a little less than 4 acres per farm is occupied by what may be called "the farmstead"; that is, the land occupied by buildings, barn yards, feed lots, etc. On this basis and the number of farms, the area in farmsteads is estimated at about 24,000,000 acres. The area in private lanes and roads not used for grazing or in timber was roughly estimated by assuming an eighth of a mile per farm, 2 rods wide. The acreages of crops not harvested because of crop failure and of crop land lying idle or fallow are based on partial results of a tabulation of this census inquiry now being made by the Bureau of the Census in cooperation with the Bureau of Agricultural Economics (Division of Land Economics). The estimate of marsh lands in farms is based in part on soil surveys and in part on the census. The item of idle and fallow crop land is a rough estimate based on incomplete tabulations of replies to a census question on this subject. The item on waste land is a residuum.

[6] Most of the items in this total of 134,000,000 acres have been mentioned. They include the following in round millions of acres: Public roads, 20; cities and villages, 10; railroads, 4; national parks, 6; farmsteads, 24; lanes in farms, 3; sandy beaches, 1; rocky peaks and other rocky outcrop areas, 20; land too arid for grazing and nonirrigable, 30; marsh and swamp land of no potential value for any of the three uses, 16.

the area ultimately available for crops, pasture, and forest to approximately 1,734,000,000 acres of land.[7]

Land Now Used for Crops, Pasture, and Forest.

About 1,666,000,000 acres, or 94 per cent of the 1,769,000,000 acres available for crops, pasture, and forest, are now employed for one or more of the three uses (fig. 1).[8] However, very large areas are of low productiveness and will be always, even allowing for future progress; and other large areas are greatly under-used.

Thus, it is estimated that 587,000,000 acres, or nearly a third of the total available area, are arid or semiarid pasture and range. All of this land is in the West. For the most part, the carrying capacity is very low, requiring an estimated average of 24 acres to maintain an animal unit for the grazing season. In spite of the enormous magnitude of the area, amounting to more than six times the farming area of Germany before the World War, it is estimated that in 1920 it supplied pasture for the grazing season sufficient to maintain without supplemental feed only a little more than 24,000,000 animal units,[9] or about 22 per cent of the total livestock on farms and

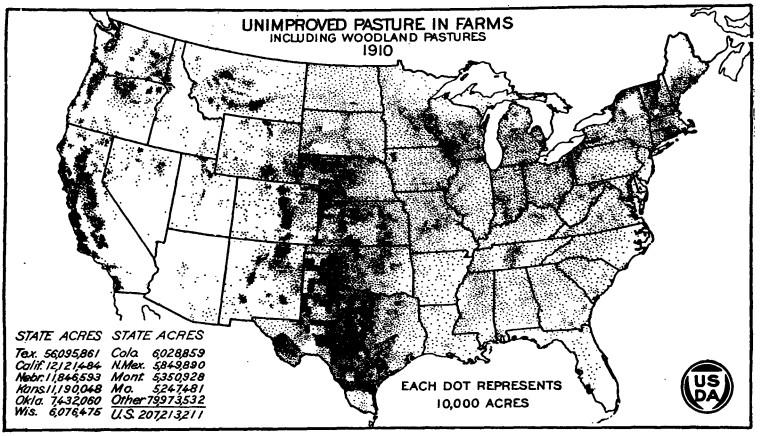

FIG. 3.—The largest acreage of unimproved pasture in farms, including woodland pastures, as reported to the census enumerators in 1910, was in the subhumid to arid Great Plains region, notably in Texas, and in the valleys and plateaus of the Pacific Coast States. In addition to the unimproved pastures in farms in the West there is a much larger acreage of similar but usually more arid land not in farms. Since 1910 a large area of range-land in the West has been added to the farming acreage. Large acreages of unimproved pasture will also be noted in the steeply rolling to rough lands of the upper Mississippi Valley and in the hilly New England States. Similar information was gathered in the 1920 census, but has been tabulated as yet only for a few States.

ranges in the United States. Allowing for the winter feed needed, this pasture and range land supplied approximately 16 per cent of the sustenance needed during the year by all livestock.

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[7] It is probable that the area of cities, roads, railways, and farmsteads will not increase so rapidly as the increase of population.

[8] Includes 15,000,000 acres of crop failure.

[9] The animal unit is a means of measuring the feed requirements of livestock. It is the equivalent of a mature horse, cow, or steer, 5 hogs, 7 sheep or 100 poultry. For very young animals double the equivalent of an animal unit for mature stock of the same kind is allowed. On semiarid grazing land the ratio is more properly 3 to 5 mature sheep to each cow.

A small part of this area of semiarid and arid pasture (about 44,000,000 acres, much of which is piñon-juniper and chaparral) is included in the national forests (see top bar of figure 1). This area is used for grazing under careful regulations which make for efficient use. Another area subject to public restrictions is the semiarid grazing land included in Indian reservations. About 141,000,000 acres of semiarid grazing land are in the unreserved public domain, and are used as an unrestricted grazing commons, which results in the most inefficient utilization and which has caused a great deterioration in the quality of the range. Somewhat better employed are the 67,000,000 acres of other publicly owned land, mostly belonging to the States, and the 172,000,000 acres privately owned but not in farms. However, over much of this land the range is almost as badly overgrazed as in the public domain. The 163,000,000 acres in farms, of which 10,000,000 are reported improved, are not subject to the devastating effects of competitive grazing by rival stockmen;

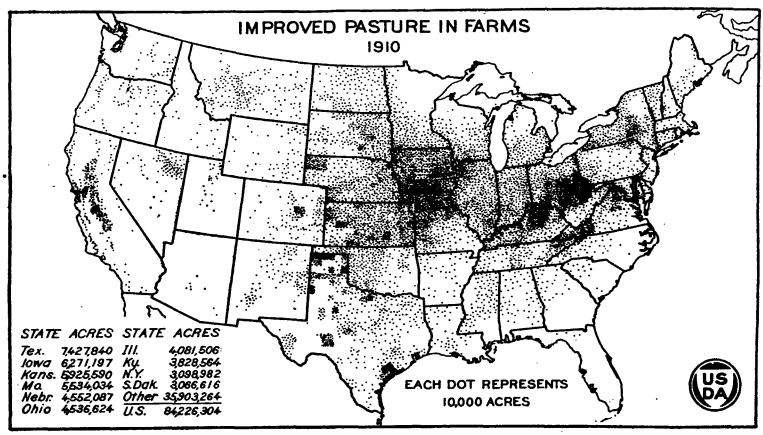

FIG. 4.—The largest acreage of improved pasture in 1910 was in the upper Ohio Valley, the western portion of Corn Belt, the southern part of the hay and dairying region, and the eastern portion of the Great Plains; in other words, in the best general farming and livestock-producing sections of the United States. The concentration of pasture acreage shown in certain Texas counties in the map above, and also in Figure 3, is largely due to the census reporting total acreage of ranches as being located in the same county as the ranch headquarters are located, and includes, therefore, ranch land lying in adjacent counties. These maps are based on a special tabulation of the census schedules made by the Department of Agriculture and published in department Bulletin 626.

but, for the most part, the ranchers have not developed conservative methods of using their land (fig. 3).[10]

Humid grassland pasture—that is, humid pasture other than woodland—occupies an area estimated at 231,000,000 acres, with a carrying capacity averaging about one animal unit per 5 acres. Of this area about 60,000,000 acres are improved pastures in farms (fig. 4), consisting mostly of rotation pastures and permanent seeded pastures with an estimated average carrying capacity of one animal unit to 2½ acres for a 6-month season. About 88,000,000 acres are unimproved pasture in farms (fig. 1), with an average carrying capacity estimated at one animal unit to 5½ acres.[11] The

[10] For method of estimating the area and carrying capacity of pasture in the United States see the preceding article, "Our Forage Resources," p. 369.

[11] See discussion of pasture land in preceding article entitled "Our Forage Resources."

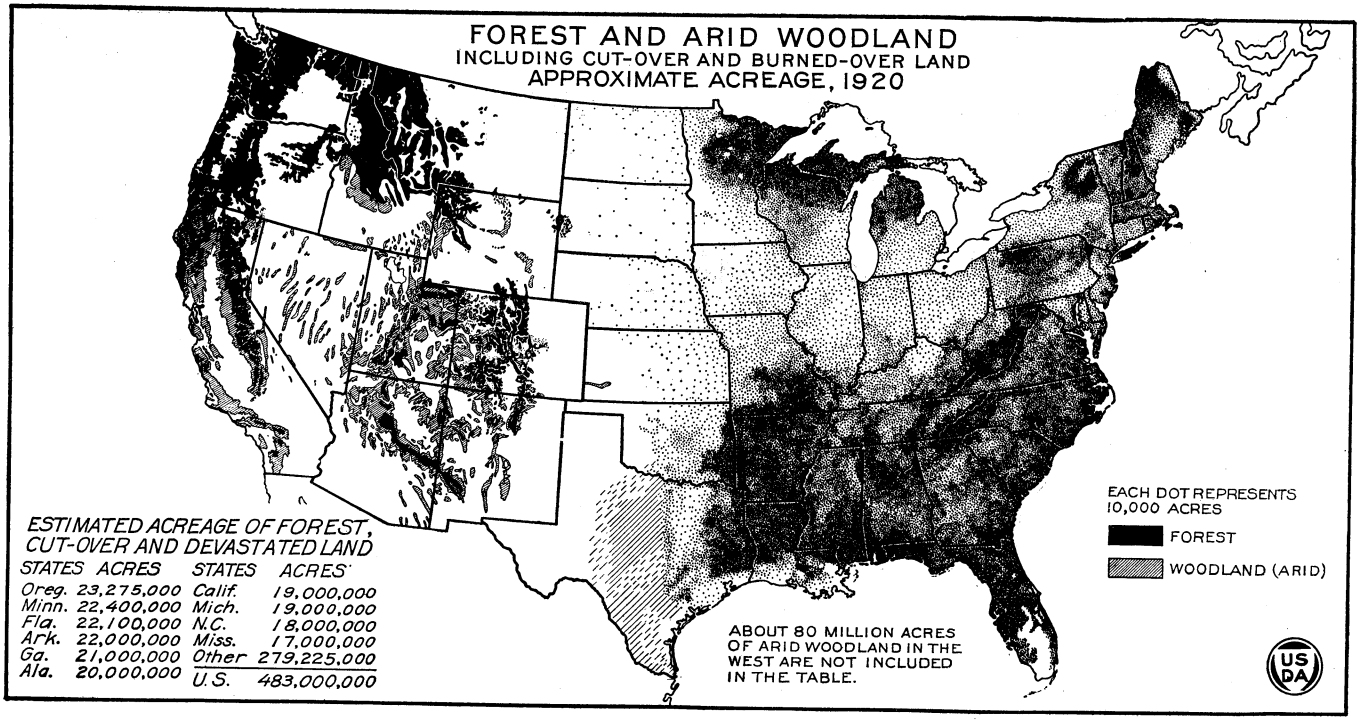

FIG. 5.—This generalized map of forest areas, including cut-over and burned-over lands and arid woodland, was prepared in cooperation with the Forest Service. The figures given in the table are merely tentative. As a result of more recent estimates the statistics for individual States are somewhat different from estimates previously published. The estimates for the originally forested eastern portion of the United States, except for several States in which forest surveys have been made, are based largely on deductions from the statistics of the 1920 census. These compilations were made by counties. Of the 483,000,000 acres of forest and cut-over land in the United States, about one-half is in the South, one-eighth in the Northeastern States, one-eighth in the Lakes States, and nearly one-quarter in the West, mostly in the Rocky Mountain and north Pacific regions. However, over half of the 138,000,000 acres of virgin saw timber is in the West.

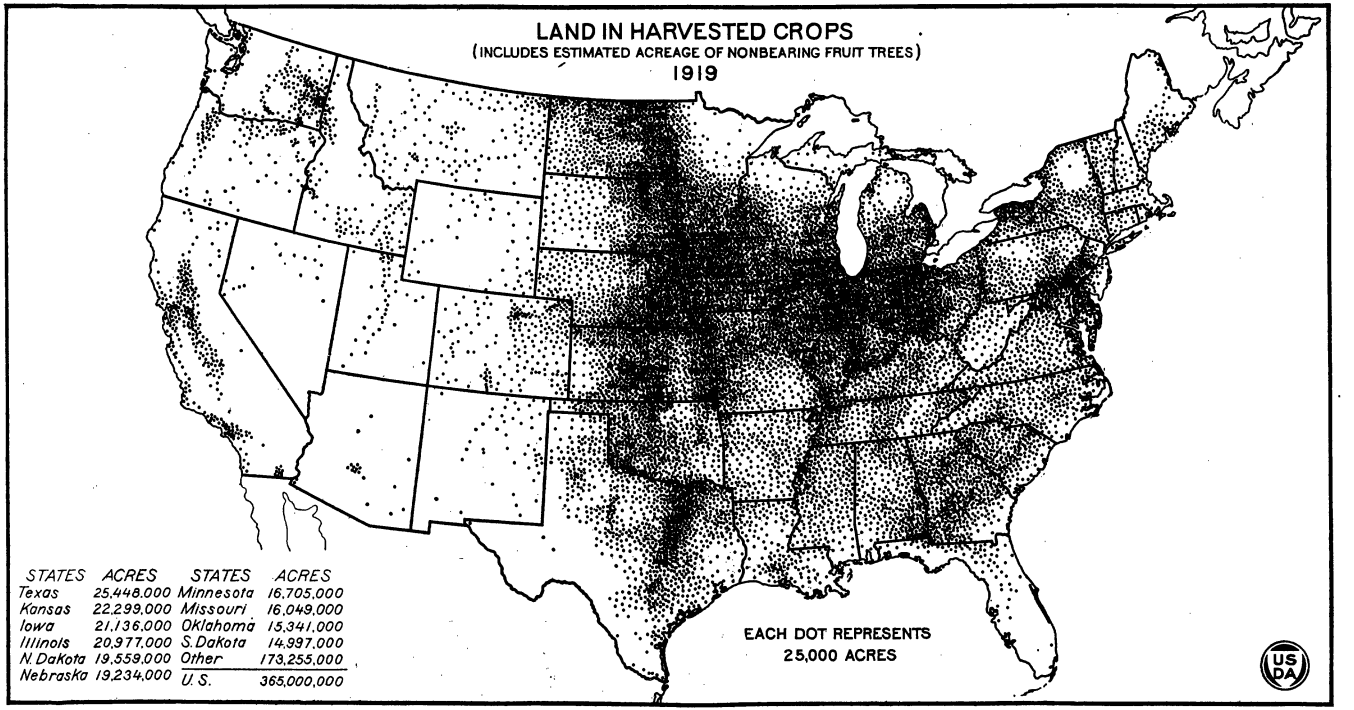

FIG. 6.—Over five-sixths of the crop land is in the humid eastern half of the United States, and nearly two-thirds is concentrated in a triangular-shaped area, the points of which are located in western Pennsylvania, central Texas, and north central North Dakota. In this area, which includes only about one-fourth of the land of the United States, are produced four-fifths of the corn, three-fourths of the wheat and oats, and three-fifths of the hay crops of the Nation. No region in the world of equal size affords so favorable natural conditions for the growth of corn, and few regions possess so favorable conditions for the culture of the small grain and hay crops.

remaining area is publicly owned land or privately owned land not in farms. (See bottom bar of figure 1.)

Another large area is classed as forest (including cut-over and burned-over land), estimated at 483,000,000 acres, or 27 per cent of the total area available for the three uses (fig. 5). However, of this amount 81,000,000 acres are cut-over land not restocking, that is, not becoming reforested, and 142,000,000 acres are timber of cordwood size. About 260,000,000 acres are saw timber, of which only 138,000,000 are virgin forest.[12] Of the total forest, cut-over and burned-over area, it is estimated that about 237,000,000 acres are employed for grazing. Almost one-third of this is in the national forests and Indian reservations, about one-third is wood lots in farms used for grazing, and the remainder is privately owned land not in farms. The carrying capacity of this forest and cut-over pasture is very low, estimated at an average of about 23 acres per animal unit for a 6-month season.

In addition to the 483,000,000 acres classed as forest, there is an area of about 80,000,000 acres of mesquite, piñon-juniper, live oak, and chaparral, nearly all of which is included in the area of semi-arid grazing land. The wood on this land is useful for fuel and fence posts, and will undoubtedly be more widely used when the price offered justifies transportation to centers of consumption. (See fig. 5.)

Land in crops harvested in 1919 is estimated at 365,000,000 acres (fig. 6), or only a little over one-fifth of the total area available for the three uses. However, there is always a considerable area of land planted to crops not harvested, mainly on account of crop failure. This is estimated roughly at 15,000,000 acres for 1919. There was also an area of crop land lying idle or fallow estimated at 25,000,000 acres. Some of this probably consists of old fields recently abandoned.[13]

Land Potentially Available for Crops, Pasture, or Forest.

With the agricultural development of the United States, the acreage of crops has been more or less constantly expanding, in earlier periods largely at the expense of forest, and more recently mostly at the expense of pasture (see fig. 20). This process will probably continue with the increase of population, and although it is unlikely that the limits set by physical conditions to the expansion of crop land will ever be reached, it is helpful in studying the problems of crop-land utilization to determine what these extreme physical limits are. From this point of view, the estimated potential areas of land capable of being used for crops are shown in Figure 10.

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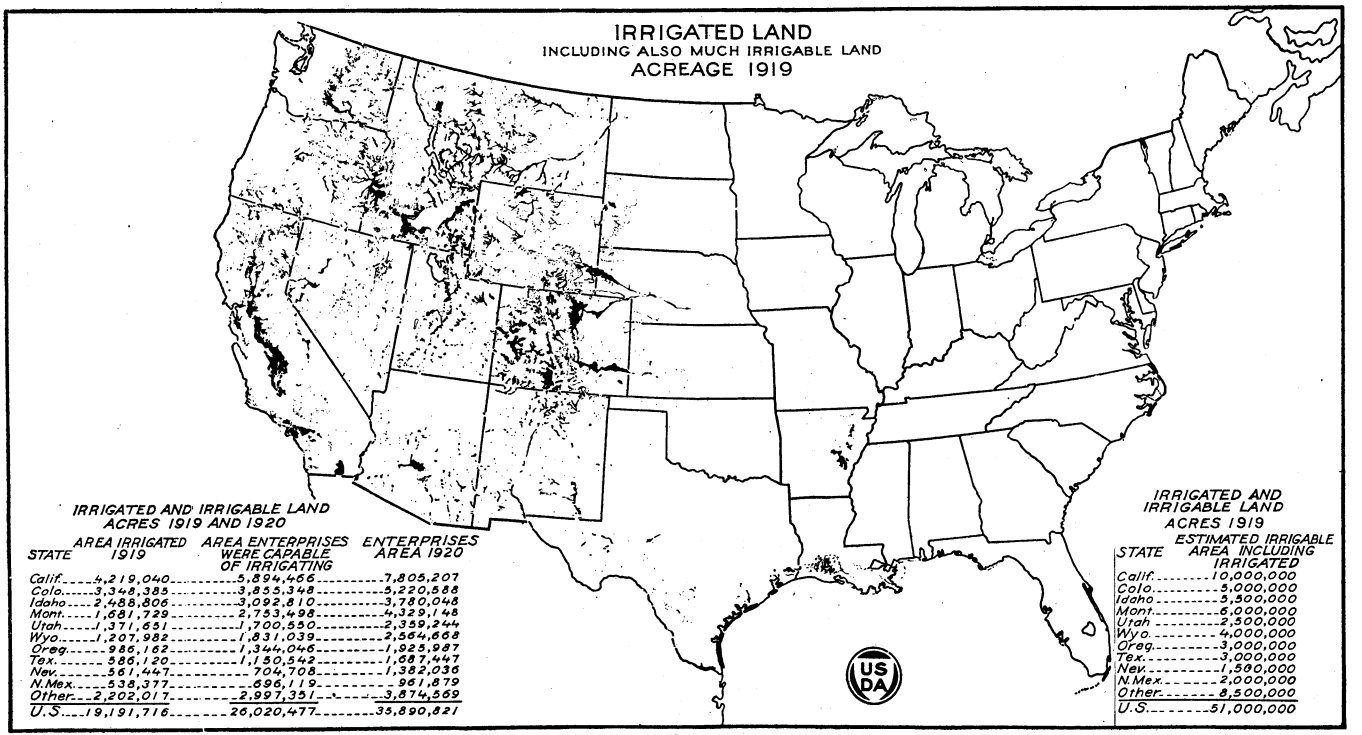
[12] These estimates are somewhat larger than those given in the so-called Capper Report ("Timber Depletion, Lumber Prices, Lumber Exports and Concentration of Timber Ownership," Report on Senate Resolution No. 311, United States Forest Service, 1920), or the article "Timber: Mine or Crop?" in the 1921 Yearbook. In the eastern originally forested region the figures are based on tabulations, by counties, of census statistics with due allowance for roads, railroads, cities, etc., except that where forest surveys have been made these figures were used instead. In the West the figures are based on estimates by the Forest Service of timberland in the national forests and privately owned. These estimates have been increased to allow for forest land in Indian reservations and in the public domain. Further study is being given the matter, and the figures will doubtless be modified as a consequence.

[13] The area for the various harvested crops whose acreage was reported in the census totaled only 348,000,000 acres, but estimated additions for corn fodder, fruits, and other items bring the total up to 365,000,000.



IRRIGATED AND IRRIGABLE LAND
ACRES 1919 AND 1920

STATE	AREA IRRIGATED 1919	AREA ENTERPRISES WERE CAPABLE OF IRRIGATING	ENTERPRISES AREA 1920
Calif.	4,219,040	5,894,456	7,805,207
Colo.	3,348,385	3,855,348	5,220,588
Idaho	2,488,806	3,092,810	3,780,048
Mont.	1,681,729	2,753,498	4,329,148
Utah	1,371,651	1,700,550	2,359,244
Wyo.	1,207,982	1,831,039	2,564,668
Oreg.	986,162	1,344,046	1,925,987
Tex.	586,120	1,150,542	1,687,447
Nev.	561,447	704,708	1,382,036
N.Mex.	538,377	696,119	961,879
Other	2,202,017	2,997,351	3,874,569
U.S.	19,191,716	26,020,477	35,890,821

IRRIGATED AND IRRIGABLE LAND
ACRES 1919

STATE	ESTIMATED IRRIGABLE AREA INCLUDING IRRIGATED
Calif.	10,000,000
Colo.	5,000,000
Idaho	5,500,000
Mont.	6,000,000
Utah	2,500,000
Wyo.	4,000,000
Oreg.	3,000,000
Tex.	3,000,000
Nev.	1,500,000
N.Mex.	2,000,000
Other	8,500,000
U.S.	51,000,000

FIG. 7.—The area of irrigated land increased 5,000,000 acres, or one-third, between 1909 and 1919; and the irrigation enterprises were capable of irrigating 7,000,000 acres more than were actually irrigated in 1919. There is sufficient water in the West to irrigate double the area that existing enterprises were capable of irrigating in 1920, or about 50,000,000 acres, when higher prices of farm products justify the constantly increasing cost per acre of construction of irrigation works. California, Colorado, and Idaho lead in irrigated acreage at present; but Montana rises into second place in the estimate of total irrigable area. Estimates of irrigable area were supplied by R. P. Teele.

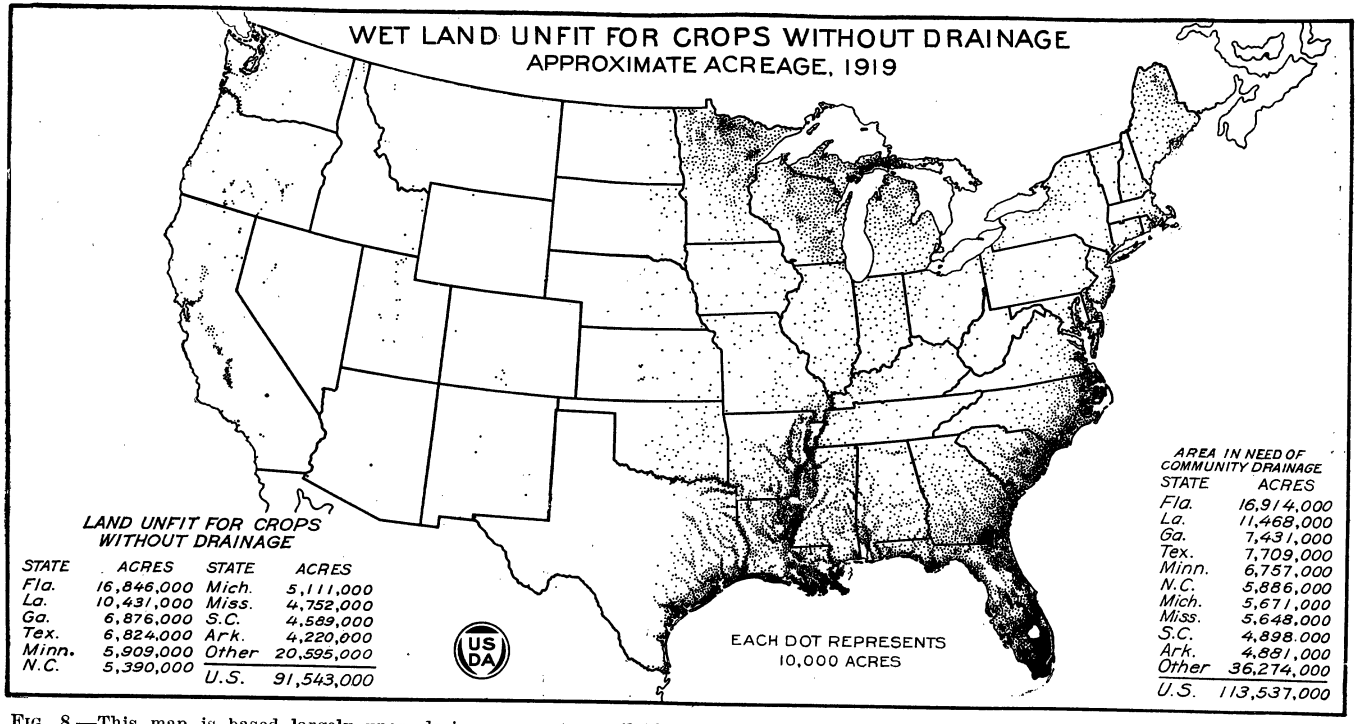
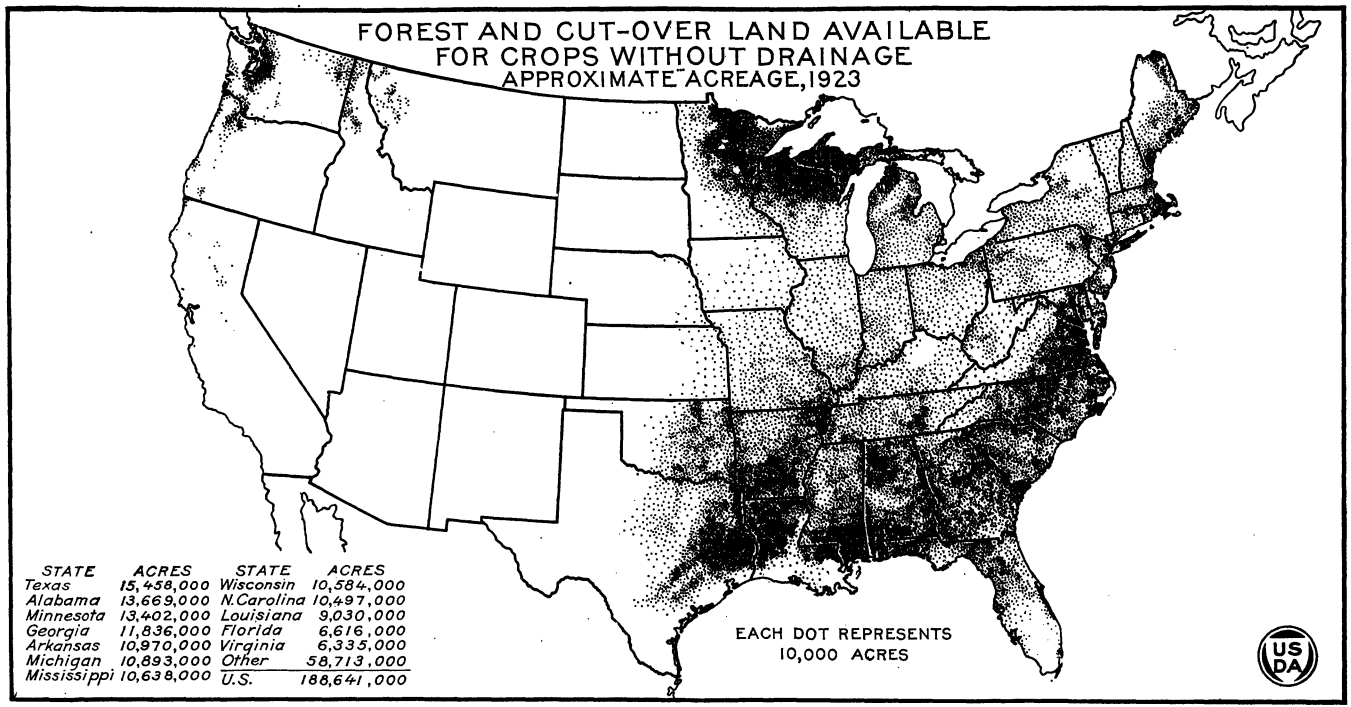


FIG. 8.—This map is based largely upon drainage reports available in the Division of Agricultural Engineering (Drainage Investigations), and upon maps of the United States Soil Survey, United States Geological Survey, and the General Land Office. These reports and maps were compared with statistics of drainage enterprises and of land in farms needing drainage, available for the first time in the 1920 census, by L. A. Jones, of the Bureau of Public Roads, and F. J. Marschner, of the Bureau of Agricultural Economics. Two-thirds of the land unfit for cultivation without drainage is in the Southern States and one-half of the remainder is in the three Lakes States. Nearly all of the wet land in the South, except the Florida Everglades and prairies, tidal marshes, and Gulf coastal prairies, is forested, and requires both drainage and clearing; but much of the wet land in the Lakes States consists of unforested peat bogs. Of the 91,000,000 acres or more of wet land it is estimated that only 75,000,000 acres can be drained at a cost that will ever prove feasible.



STATE	ACRES	STATE	ACRES
Texas	15,458,000	Wisconsin	10,584,000
Alabama	13,669,000	N.Carolina	10,497,000
Minnesota	13,402,000	Louisiana	9,030,000
Georgia	11,836,000	Florida	6,616,000
Arkansas	10,970,000	Virginia	6,335,000
Michigan	10,893,000	Other	58,713,000
Mississippi	10,638,000	U.S.	188,641,000

FIG. 9.—This map is based on compilations by counties for the eastern forest region, including a marginal woodland belt containing about 19,000,000 acres, along the western edge of the forest region in Texas and Oklahoma. The study also included the Pacific Coast States, the Idaho Panhandle, and northwestern Montana. Most of the region in between is either arid or so mountainous that forest land suitable for crops is available only in small areas characterized for the most part by a very short growing season, and is insignificant in amount. Only a small proportion of the available forest and cut-over land in the eastern half of the United States comprises land even of fair quality. Much of this land would require heavy expenditure for fertilization in addition to the expense for clearing. By far the greater part consists either of sands or light sandy loams. The map is based on information gathered by the Soil Survey and descriptive data in the General Land Office survey records, and was prepared by F. J. Marschner, Bureau of Agricultural Economics (Division of Land Economics).

It appears that about 100,000,000 acres more of improved land, mostly improved pasture, are potentially available for crop production. The rapid increase in crop acreage during the World War came largely from this improved pasture land. There are also about 30,000,000 acres more of land in the West which it is possible to irrigate (fig. 7) and about 75,000,000 acres more of potential crop land unfit for crops without drainage, though the greater part of it must also be cleared of timber or stumps (fig. 8). A large area of humid unimproved land, estimated at 235,000,000 acres, is physically capable of crop production without drainage. About 170,000,000 acres of this are forest and cut-over land, located mostly in the South and in the Lake States (fig. 9). Finally, there are about 52,000,000 acres of subhumid lands, mostly in the Great Plains region,

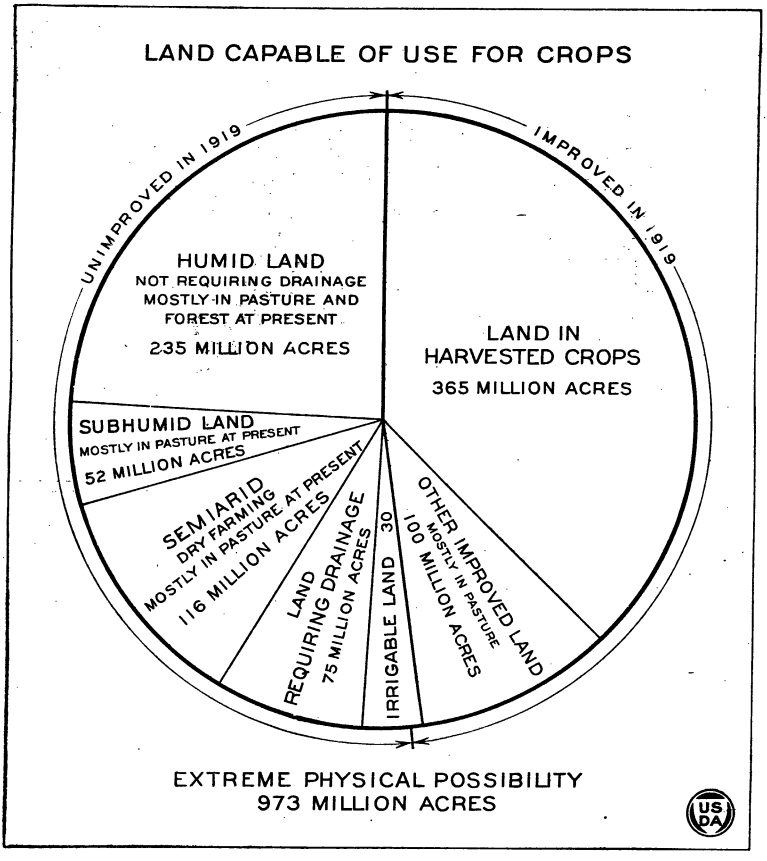


FIG. 10.—In addition to the 365,000,000 acres of land in harvested crops in 1919, it is estimated that there are also about 600,000,000 acres physically capable of being utilized for crops some time in the future. This includes practically all the land that is not too rough, rocky, sandy, cold, or dry, or that is not now employed for uses other than agriculture and forests. Consequently it includes some land that it will not be economical to reclaim for crops even when we reach our maximum population. It also makes no allowance for pasture, except semiarid pasture too dry for crops and a small amount of humid pasture too rough for cultivation, nor for land needed for the expansion of urban areas, roads, railroads, etc. Undoubtedly, a part of this potential crop area will always be employed for pasture. Most of the figures are based on estimates.

and possibly 116,000,000 acres of semiarid land, mostly east of the Rocky Mountains, which could, if necessary, be utilized for dry-land crops.[14]

There are in all, therefore, about 608,000,000 acres of potential crop land, which, added to the 365,000,000 acres in harvested crops, orchards, vineyards, etc., make a total of 973,000,000 acres (fig. 10). When one recalls the fact that the crop area of the German Empire before the World War was only about 70,000,000 acres,[15] the above area appears enormous. However, for a number of reasons the estimate of potential crop area gives an entirely unreal and illusory conception of our available resources.

In the first place, as noted above, this is the area of land that is physically capable of being employed for crops when our need shall become so extreme that considerations of cost of utilization are relatively secondary. Thus, of the land capable of being employed for crops, pasture, and forest in the originally forested region of the eastern half of the United States, there is excluded only the land too rough for crops and about 16,000,000 acres of loose sands which it was considered proper to regard as suitable only for forest (fig. 11). The area indicated as capable of being employed for crops is mostly land that would have to be cleared of timber or of brush and stumps, much of it at heavy cost. Only about 32,000,000 acres are classed as heavy soils. The remainder consists of 162,000,000 acres of soils of medium texture and 26,000,000 acres of fine sands. Most of the former area is light sandy loam. Without doubt practically all of the area of fine sands and a large proportion of the medium-textured soils are of low productivity; but they constitute a reserve area of considerable importance for vegetables, fruits, and other intensively cultivated crops, notably cotton and tobacco. Probably heavy annual fertilization will be required for most of this land. Moreover, a considerable part of the area, though not absolutely too rough to be used for crops, is so

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[14] These various items were estimated as follows: Improved land potentially capable of being added to crop area: From the total area of improved land reported in the census of 1920 (503,000,000 acres) was subtracted the estimated areas in harvested crops (365,000,000), farmsteads (24,000,000), all of which was considered improved land, and a small allowance for roads and lanes and other minor items. There was included an area of 60,000,000 acres of improved pasture, estimated on the basis of 1909 statistics which were tabulated by the Department of Agriculture from the census schedules and published in Department Bulletin 626, and similar statistics for 1919, now available for certain States.

Land capable of irrigation: Estimated by R. P. Teele, Bureau of Agricultural Economics (Division of Land Economics), on the basis of various surveys made by the Reclamation Service, Bureau of Public Roads (Irrigation Investigations), and the United States Geological Survey.

Estimates of drainable land were compiled by L. A. Jones and F. J. Marschner from data in the Bureau of Public Roads (Drainage Investigations), reports and maps of the Soil Survey, topographical maps of the Geological Survey, and various State reports, supplemented by the results of the 1920 census. The total drainable area of 91,000,000 acres has been reduced to 75,000,000 acres to allow for certain areas of very deep peat and some of the coastal marsh which would not be suitable for crops.

Humid unimproved land: This estimate is based on a classification of the land by counties, made by F. J. Marschner, Bureau of Agricultural Economics (Division of Land Economics), with the cooperation of Dr. C. F. Marbut, Bureau of Soils. This classification was made largely on the basis of available data in the United States Soil Survey, United States Geological Survey, United States Land Office, and various State surveys and other State sources of information.

The subhumid prairie region and the semiarid and arid portions of the Great Plains and of the Rocky Mountains interior plateaus, and Pacific coast regions: The estimates were made by O. E. Baker, Bureau of Agricultural Economics (Division of Land Economics), on the basis of the census statistics on the use of land in farms, in process of tabulation, and for land outside of farms, on the basis of data assembled by the Land Classification Board of the United States Geological Survey, supplemented by climatic records and data from the Soil Survey and the Forest Service.

[15] Including areas classified as bare fallow; green manure crops and fields under natural grass; "trees, shrubs, and bushes" (i. e., orchards and small fruits). For a given year, of course, fields under natural grass are more properly considered pasture, but they comprise land that comes into crops during the course of the rotation.

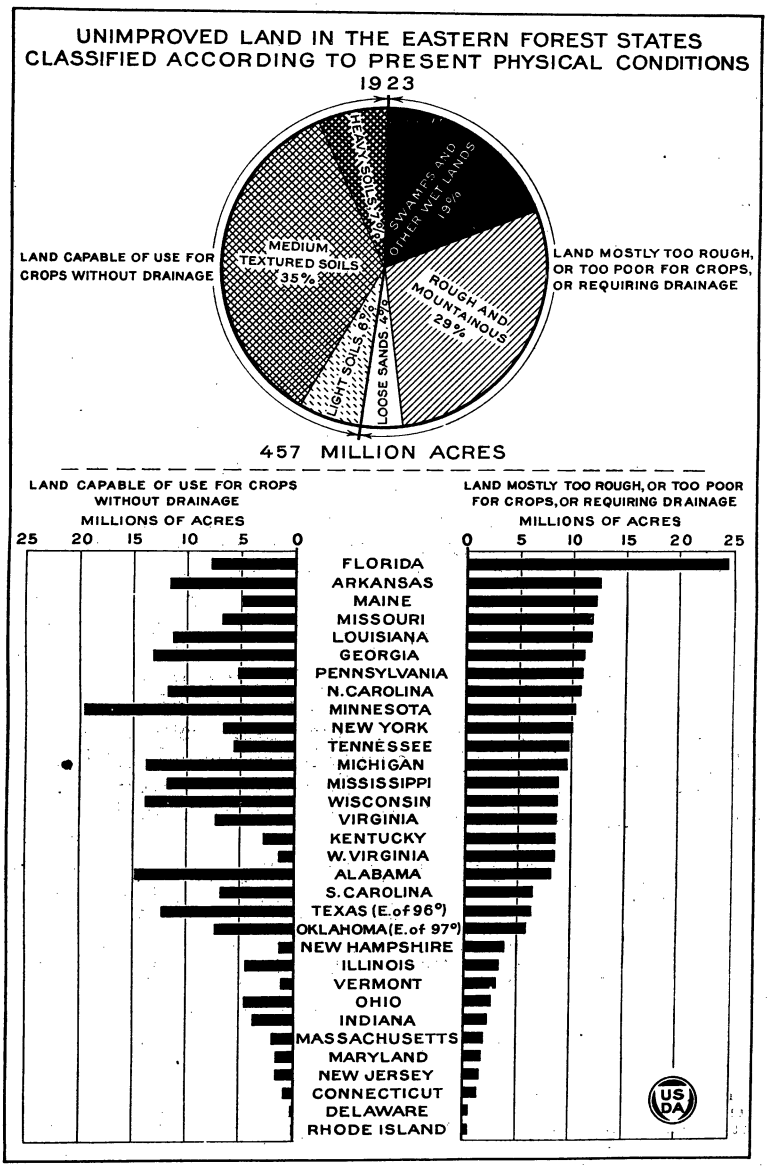


FIG. 11.—Most of the 220,000,000 acres in the region capable of use for crops without drainage is now forest or cut-over eastern originally forested land. There are about 9,000,000 acres more of such land in the Prairie States. The light soils will, in general, need more fertilizer than the heavy soils. The soils of medium texture are mostly sandy loam. The swamps and other wet lands are also forested for the most part, and will, therefore, require clearing in addition to drainage. At least 15 per cent of these swamp lands, owing to adverse conditions, is unlikely ever to be drained. Some of the rough, mountain land can be used for orchards, provided the slopes are kept in sod; but the amount of land likely to be so used is very small. Similarly some of the loose sands can be used for crops provided fertilizer is liberally applied, but the extent of such land will remain very small so long as better lands are available. Undoubtedly most of these 457,000,000 acres of land will not be needed for crops until at least another crop of timber can be cut (see p. 495).

rolling that erosion would probably result in serious soil depletion. Some of this land in the northern portion of the Lake States is also subject to summer frosts. Most of the potential crop land in the eastern forest region is either in the Southern States or in the northern parts of Minnesota, Wisconsin, and Michigan (fig. 9).

Of the estimated 75,000,000 acres capable of being employed for crops after drainage (fig. 8), probably about 68 per cent would also have to be cleared of trees or stumps and brush. Much of the drainable land is fertile, but considerable areas are either deficient in fertility or the soils are of undesirable texture.

The reclamation of arid land by irrigation (fig. 7) also involves heavy costs. The steady increase in average cost per acre for irrigation, which was about eight times as high for projects begun in the decade 1910–19 as for projects begun prior to 1890, suggests that the easier projects were first undertaken and that much of the remaining area classed as irrigable will require extremely heavy costs for construction of dams and ditches.

Of the 100,000,000 acres of so-called improved land not used for crops, a considerable part is probably potential crop land of fair quality. In fact, an estimated 15,000,000 acres is land actually employed for crops but not harvested in 1919. Much of this is land in the semiarid crop regions of the West, however, where crop failure because of inadequate rainfall is frequent. About 25,000,000 acres is crop land which is idle or fallow. This is found mostly in the semiarid wheat areas of the West, where bare fallowing to conserve moisture is practiced, and in the South and East, where many unprofitable fields have been allowed to grow up to broom sedge and weeds. Much of the 60,000,000 acres of improved land in pasture is pasture in rotation with crops, probably the equal of the crop land in fertility; and most of the remainder is fertile permanent pasture. However, to devote any large part of this area to crops without providing a substitute by the improvement of pasture now classed as unimproved would result in the serious disturbance of the necessary relationship of pasture to crops in the systems of farming.

The potential crop land in the subhumid prairies comprises land which hitherto has not been employed for crops or for improved pastures, either because of rough topography or the presence of stone or because the soil is shallow or infertile. Most of this area is in central Texas and Oklahoma.

The potential crop land in the semiarid portion of the Great Plains region has mostly so low a rainfall that an average yield of wheat year in and year out would probably be not more than 7 bushels to the acre. The price of wheat would need to be much higher than at present to make its production profitable under these circumstances In fact, much of the land in this region which has been planted to wheat has proved to be unprofitable at the present level of prices. However, when the population of the nation becomes much greater than at present, considerable portions of this area may be used for grain production, supplemented by the raising of livestock on forage crops, range pasture, and the straw and stubble.

Of the estimated area of 18,000,000 acres of potential crop land west of the Great Plains not irrigable or drainable, about one-third is humid or subhumid land in the Pacific Coast States or in mountain parks. Most of this humid land is covered with heavy forests or

with the large stumps left after lumbering. The cost of clearing is very heavy. The remaining two-thirds is largely semiarid land.

It is also important to keep in mind the fact that most of the potential crop area shown in Figure 10 is now used either for forest or for grazing, and if used for crops would not be available for these other uses. As previously noted, about 1,769,000,000 acres are available for all three uses. Of this amount, 468,000,000 acres are land so

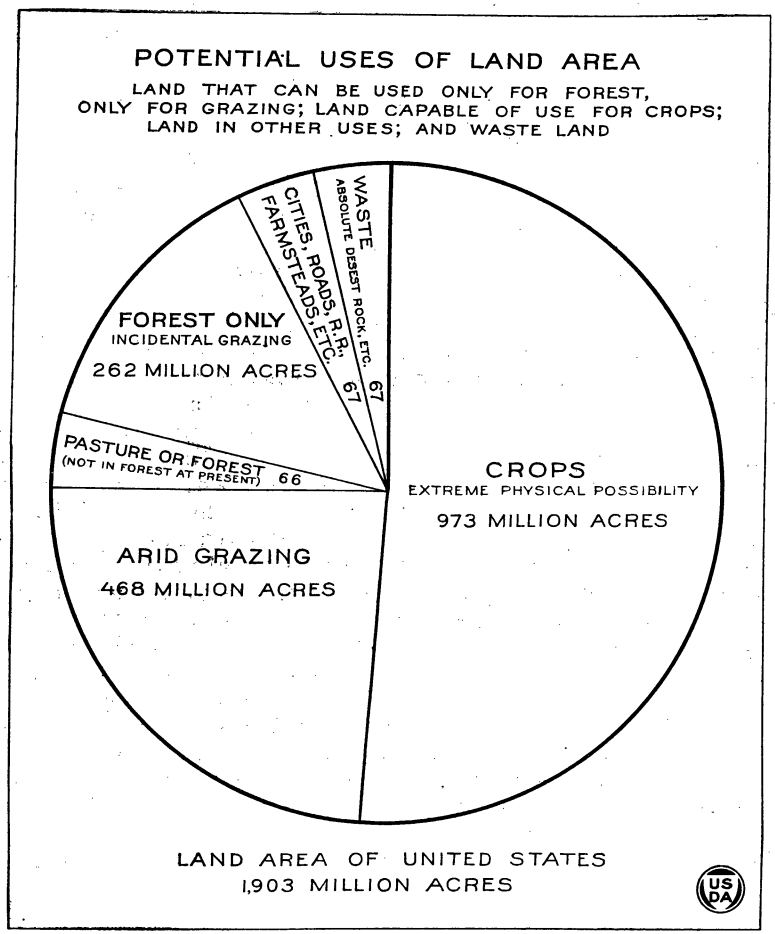
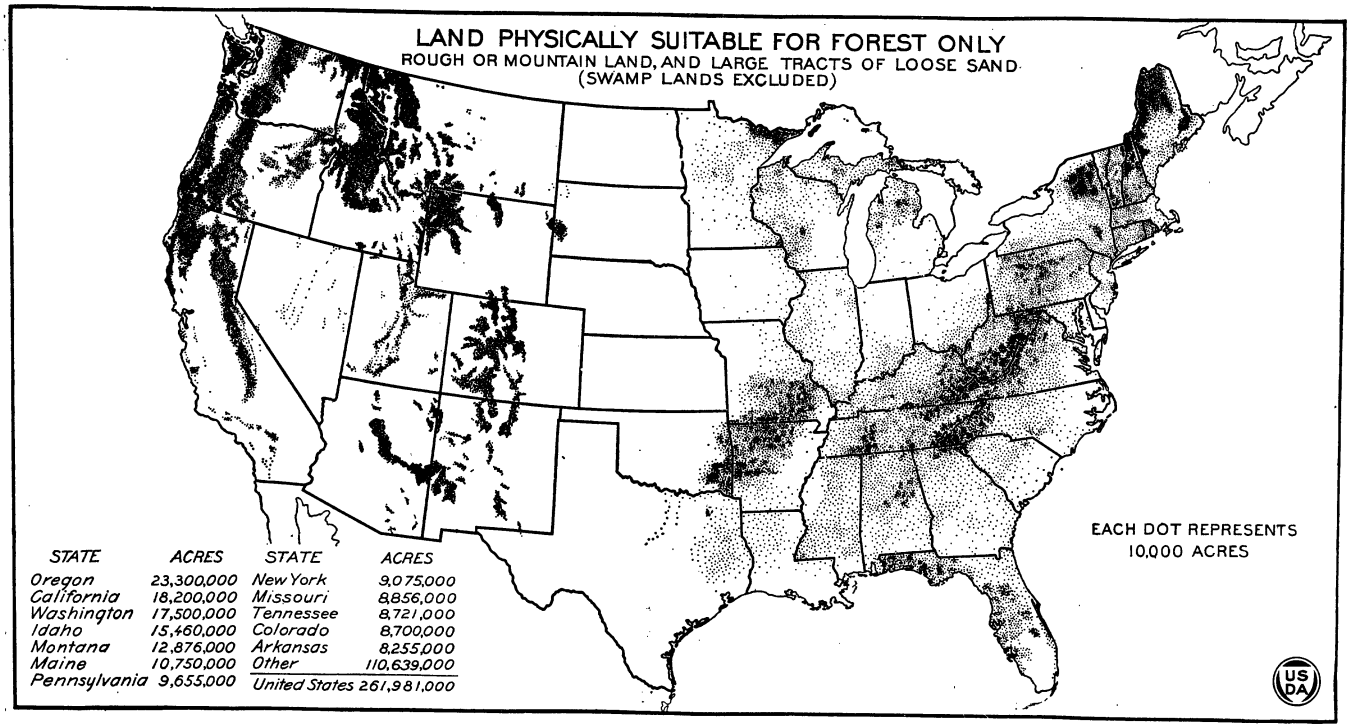


FIG. 12.—Of the 1,903,000,000 acres in the United States, about 468,000,000 acres are arid range suitable only for grazing, with very low-carrying capacity. About 328,000,000 acres are humid land, of which 262,000,000 acres are so rough or sandy that the land is primarily valuable only for forests, and 66,000,000 acres are too rough for cultivation, but used for pasture and not forested at present. About 973,000,000 acres are physically capable of use for either crops or pasture, but probably a considerable portion will remain in forest. (See fig. 10.) With the increase of population the area devoted to cities, roads, farmsteads, etc., will need to be increased somewhat. The figures are based largely on estimates.

arid that it is capable of being used only for grazing (fig. 12). Another area of 262,000,000 acres is capable of being used only for forest. Most of this is mountainous or other land of rough topography (fig. 13). Thus, if all of the 973,000,000 acres of potential crop land were employed for crops, there would remain 66,000,000



STATE	ACRES	STATE	ACRES
Oregon	23,300,000	New York	9,075,000
California	18,200,000	Missouri	8,856,000
Washington	17,500,000	Tennessee	8,721,000
Idaho	15,460,000	Colorado	8,700,000
Montana	12,876,000	Arkansas	8,255,000
Maine	10,750,000	Other	110,639,000
Pennsylvania	9,655,000	United States	261,981,000

FIG. 13.—The study on which this map is based, as in the case of Figures 9 and 11, included county compilations only for the eastern half of the United States and the Pacific Coast States. Within these regions the land classed as suitable only for forests consists of the areas too rough for crops and the areas of coarse sand. The total is about 152,000,000 acres in the East and 67,000,000 acres in the Pacific Coast States, to which have been added 53,000,000 acres in the Rocky Mountain region suitable only for forests. There are, in addition, probably 200,000,000 acres of land that can be more economically used for forests than for other purposes during the next few decades. The increase of "improved" and cleared "unimproved" farm land in the forested portions of the United States was only 5,000,000 acres between 1910 and 1920, and there seems little likelihood that there will be any great increase in the rate of clearing during the next few decades.

acres of humid pasture land other than forest or cut-over pasture. It is obvious that even a nation of very dense population would not maintain so small a proportion of pasture to crop land. In Germany, where the density of population is many times as great as it is in the humid portion of the United States, pasture, other than woodland pasture, comprises an area about two-thirds as large as the area of land in crops.

As will be shown later, the 262,000,000 acres of forest would provide, even under the best of conditions, for growing a supply of timber, for only a small part of our present per capita consumption of timber and timber products. Furthermore, in the next few decades we shall by no means need for crops all of this area of potential crop land. Consequently, the problem of future land utilization becomes one of relative requirements for the several uses. A primary object of the present study is to determine these requirements for the next few decades as a basis for indicating the nature of the land policy required.

Increasing Scarcity of Land Resources and Nature of This Scarcity.

As long as a large portion of our national domain remained unused for crops, pasture, or forest, the potential competition of these uses for our national area was not apparent. For some decades, however, we have been using for crops or for grazing the greater part of the land not occupied by forests, and during this period there has been practically no important reserve area for the expansion of any one of the three uses except at the expense of the others. Consequently, the growth of our population has resulted in an ever-increasing scarcity of our available land area, and it is important to consider some of the evidences of this scarcity.

Decrease in Per Capita Acreage of Land in Farms, of Improved Land, and of Land in Crops.

According to the census of 1920, the area of land in farms had increased more than threefold since 1850, while the area of improved land had increased nearly fivefold (fig. 14). However, the per capita acreage of farm land reached a maximum at the outbreak of the Civil War (fig. 15). The decade in which the Civil War occurred resulted in a notable decline in per capita acreage of farm land. In 1900 the per capita acreage of farm land was larger than in 1870, mainly as a result of the tremendous expansion of the area of land in farms from 1890 to 1900, but thereafter decreased. The per capita acreage of improved land in farms was at the maximum in 1880 and 1890. The per capita acreage of crop land has declined since 1900.

The decline in the per capita acreage of improved land and of crop land during the last few decades is attributable partly to the limited area of the United States available for crops, pasture, and forest. But it has been due even more to the difficulty of enlarging our crop area by the addition of land of a quality capable of being profitably used for crops.

The decline in the per capita area of farm land, improved land, and land in crops is the result of a number of factors. The cen-

AREA OF LAND IN FARMS AND AREA OF IMPROVED FARM LAND, UNITED STATES, 1850–1920; HARVESTED AREA OF 14 PRINCIPAL CROPS, 1880–1920.

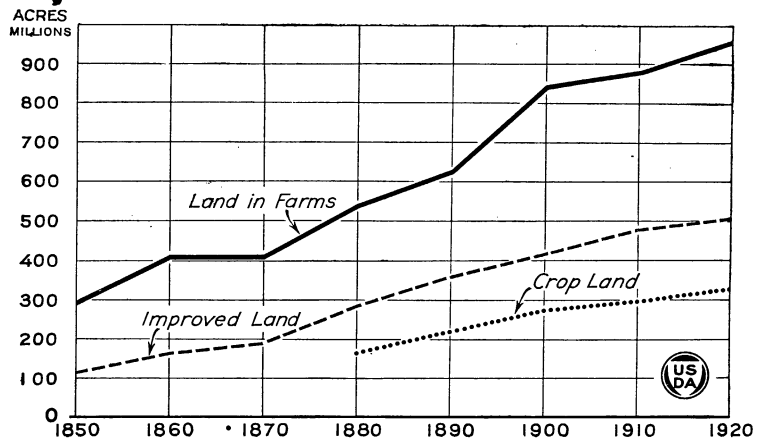


FIG. 14.—While the increase in the area of land in farms from 1850 to 1920 was greater than the increase of improved land, the rate of increase for the former was less than for the latter. However, since 1880 the ratio of improved land to farm land has been more or less constant at about 1 to 2. From 1880 (when census figures of crop acreage became available) to 1920 the harvested area of the principal crops increased at a more rapid rate than the area of all farm land or of improved farm land. In other words, the proportion of the improved land which is in crops was increasing, and the proportion in pasture was decreasing accordingly.

PER CAPITA AREA OF LAND IN FARMS AND OF IMPROVED FARM LAND, THE UNITED STATES, 1850–1920; PER CAPITA HARVESTED AREA OF 14 PRINCIPAL CROPS, 1880–1920; AND INDEX OF PER CAPITA PRODUCTION OF 9 PRINCIPAL CROPS (5-YEAR AVERAGES CENTERED ON CENSUS YEARS), 1870–1920.

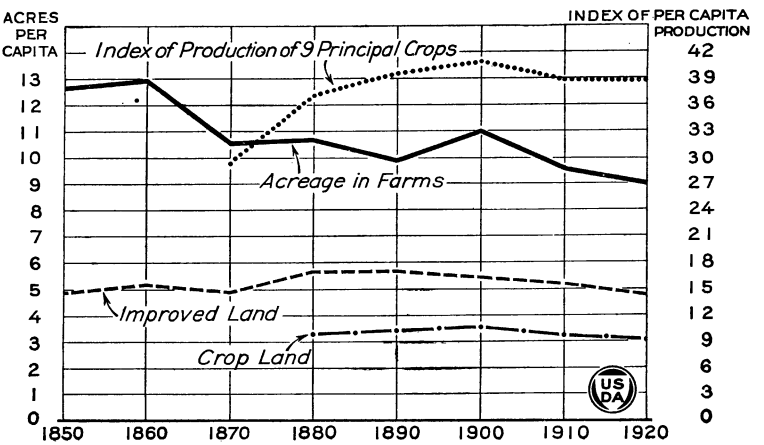
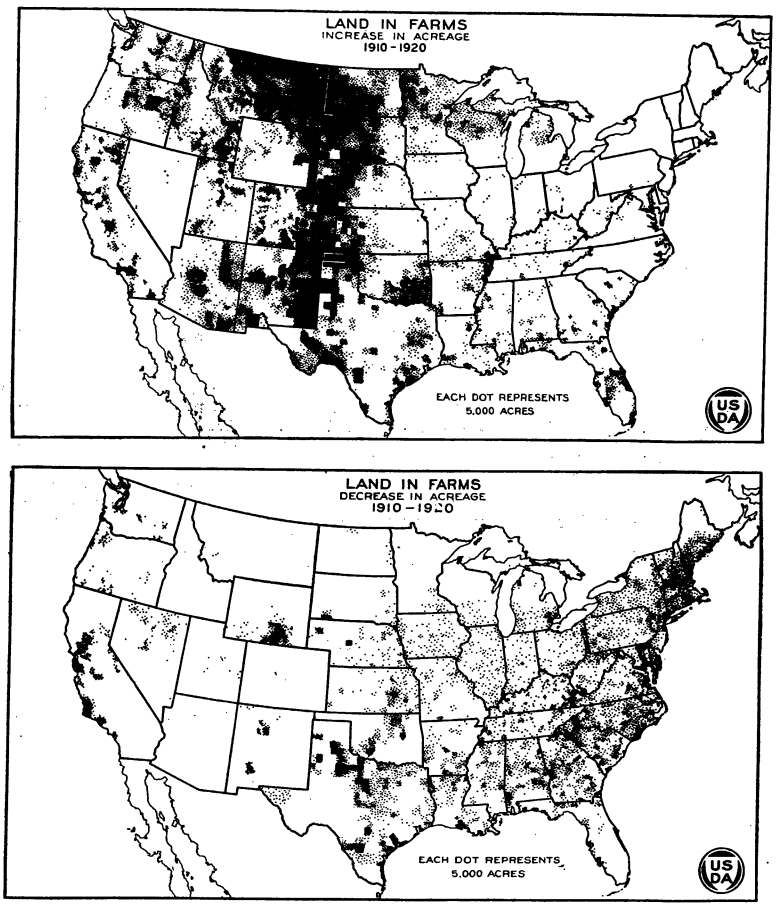


FIG. 15.—The per capita acreage of land in farms has shown a decreasing trend since 1850. The per capita acreage of improved farm land was about the same in 1920 as in 1850, but has decreased in each decade since 1890, when the maximum was attained. The per capita area of land in the 14 principal crops increased slightly from 1880 to 1900, but was less in each succeeding decade. The index of per capita production of 9 principal crops increased from 1870 to 1900, but was less in 1920 than in 1900. The data on acreage of land in farms, improved land, and crop land are from the census. The data on per capita production represent 5-year averages of Department of Agriculture estimates, centered on census years. The crops are combined on the basis of the aggregate value obtained by multiplying the total product of each by the 43-year average price. Comparable data for all decades are available for only nine crops, comprising, however, nearly 90 per cent of the total crop area.

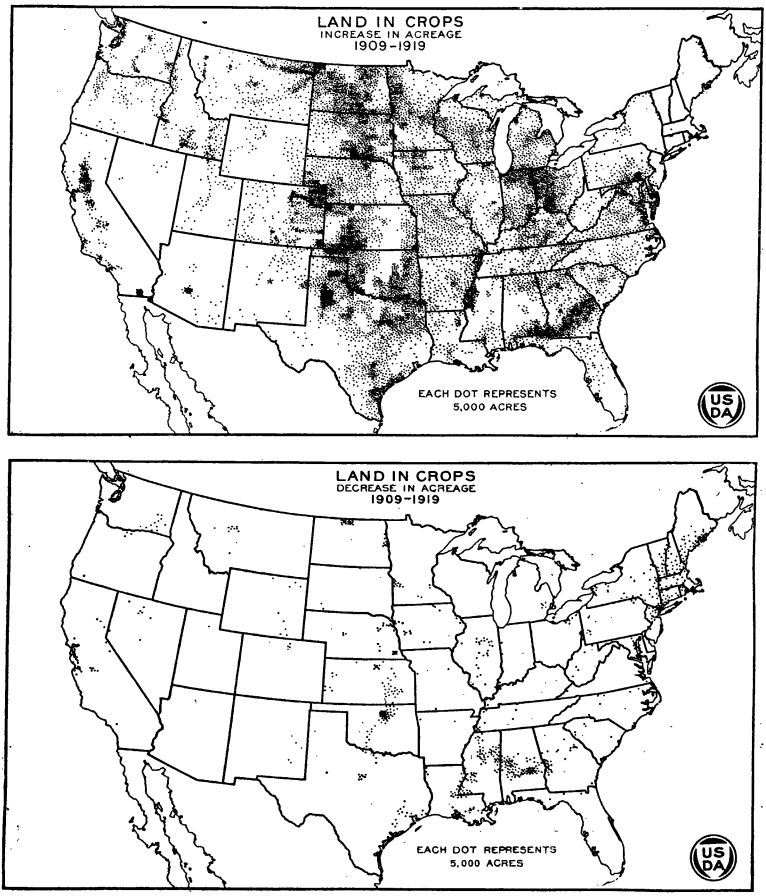
sus of 1920 revealed the fact that, since 1910, in that part of the United States east of the Great Plains, there had occurred a widespread decrease in the acreage of land in farms, amounting to 7,000,000 acres, with an increase only in a few scattered localities, the most important of which were the northern portion of the Great Lakes States, the Mississippi River bottoms, particularly in Missouri and Arkansas, and a few other districts where the reclamation of land by drainage or clearing was taking place (figs. 16 and 17). This decrease was offset by a widespread increase in the area of land in farms in the western half of the United States, amounting



FIGS. 16 and 17.—With the exception of the northern portion of the Great Lakes States, Florida, and southeastern Oklahoma, there was no notable increase in the acreage of land in farms east of the Great Plains. In the latter region and other parts of the West the great expansion of the area of land in farms was owing largely to the enactment of the enlarged homestead act, in 1909, and the grazing homestead act, in 1916, which authorized entry of 320 and 640 acres of land, respectively. With the exception of the areas mentioned, and a few other scattering districts where reclamation of one kind or another occurred, decreasing acreage of land in farms was the general tendency east of the Great Plains. The marked decreases in Texas were probably mostly nominal, being due largely to shifts of the headquarters of large cattle ranches from one county to another.

altogether to 84,000,000 acres. A large proportion of this land has proven suitable for grazing rather than for crops. In fact, the total increase of improved land in the West between 1910 and 1920 was 24,000,000 acres, much of it being the result of the improvement of land already in farms.

In spite of the general decrease of land in farms in the eastern half of the country, there was a net increase in crop land in this section amounting to nearly 25,000,000 acres, while in the western half of the country the increase was about 20,000,000 acres (figs. 18 and 19). Although this increase in crop acreage in the eastern half of



FIGS. 18 and 19.—While the area of land in farms generally decreased throughout the region east of the Great Plains (figs. 16 and 17), there was a widespread increase in the area of harvested crops in this section as well as in the Great Plains and various parts of the West. Patriotic motives, together with the inducements represented by high prices for farm products during the war and for some time thereafter, were mainly responsible for this increase, which consisted largely in the employment for crops of land formerly used for pasture. The large increase in the acreage of crops in the Great Plains corresponds with an increase in land in farms already noted. The principal regions where a decrease in crop acreage occurred were New England, the Black Prairie of Alabama, and northeastern Mississippi, a district along the Mississippi River in the southwestern Mississippi and northeastern Louisiana, and a part of northern Oklahoma. In all of the southern districts mentioned, with the exception of Oklahoma, the ravages of the boll weevil are largely accountable for the reduction in the acreage of harvested crops.

the country may include small additions to both farm area and crop area through drainage or clearing of land, it more largely comprises the using for crops of improved pasture land in farms. The fact that improved land in the United States increased only 25,000,000 acres during the decade, while the area of land in crops increased about 45,000,000 acres, indicates that a large proportion of the increase in crop area came from improved pasture land.

Since 1920 the area of farm land and of improved land has increased very little, possibly not at all, and the acreage in crops has decreased since 1919. Population, on the other hand, has probably increased somewhat more rapidly than during the decade 1910–1919, which included the war years and epidemics of influenza. The rate of decrease of per capita acreage of farm land, improved land, and crop land, therefore, has probably been more rapid since the World War than before.

Has this decrease for more than two decades in the acreage of crops per capita meant also a decline in production per capita, or may not the decrease of per capita acreage have been offset by a larger yield per acre? The answer to both questions probably must be in the negative. The index of average production per acre increased considerably from the 5-year period 1883–87 to that of 1903–07, but from the latter period until 1918–22 there was, if anything, a slight decrease in the index (fig. 45).[17]

Decrease in Area of Pasture.

The significance of the decline in the per capita acreage of crop land during the past two decades is emphasized all the more by the fact that it has been accompanied by an even more marked decrease in the per capita area of grazing land, including that without as well as within the boundaries of farms. For, whereas the area of farm land during the period was increasing, albeit, not with sufficient rapidity to keep up with the increase of population, this very increase involved a decrease in the total area of land not in farms. Nearly all the land not in farms suitable for grazing has been grazed since 1890.[18] Within the area of land in farms, crops have encroached constantly on the pasture land. Crop land increased 11.3 per cent between 1909 and 1919, whereas farm land increased only 8.8 per cent. It appears almost certain that half of the increase in crop land during this decade was at the expense of improved pasture, and much of the remaining half from unimproved pasture within or without farm boundaries. The clearing of forest land in farms and the use of this land for pasture[19] has not been nearly so

[17] Since the various crops involve products of such widely different value in proportion to weight as hay and cotton or tobacco, it was necessary to reduce them to some common denominator which would reflect their relative value over a long period. For this purpose the 43-year average price of each crop (1879 to 1922) was used as a weight in obtaining the index of average yield per acre of the principal crops.

[18] In 1880 a considerable part of the range land in the West, especially in the Dakotas and Montana, was not in use for pasture; but by 1890 nearly all of the land in the West, outside the absolute deserts, was employed for grazing, as is shown by the local distribution of livestock in the census of 1890 (fig. 26). Consequently, since 1890 it is fair to assume that all grassland brought into the classes of improved land or unimproved land other than woodland was still used for pasture, except in so far as it was devoted to increasing the crop area.

[19] Some of this forest land was used for pasture before clearing, but its value for pasture was very low in comparison with its value after clearing.

extensive as the expansion of crop land. In fact, the actual area of land used for pasture has probably decreased since 1880, and almost certainly since 1890 (fig. 20). The estimated amount of decrease per decade in pasture area since 1890 is as follows: [20]

	Acres.
1890–1899	38, 000, 000
1900–1909	11, 000, 000
1910–1919	32, 000, 000
Total	81, 000, 000

On the basis of these estimates it appears that the per capita acreage of humid pasture (exclusive of woodland) and semiarid pasture was reduced from 14.28 acres to 7.75 acres, or nearly half during the 30 years. Moreover, the carrying capacity of the pasture

TREND IN THE USE OF THE LAND AREA FOR CROPS, PASTURE, AND FOREST, UNITED STATES, 1880–1920.

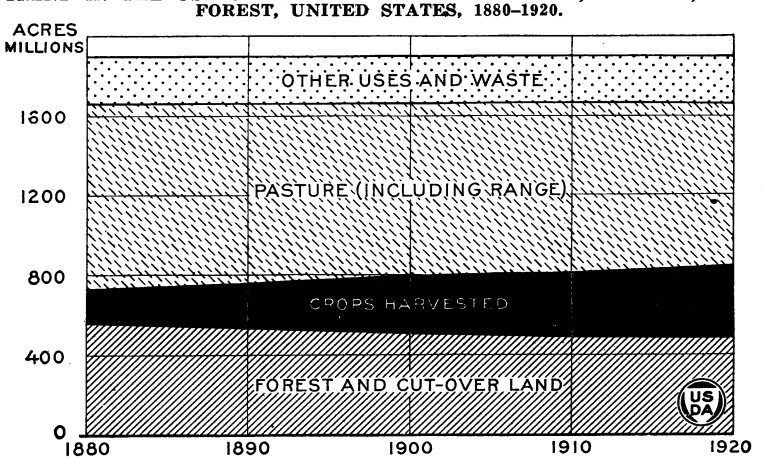


FIG. 20.—The area of land in harvested crops has steadily increased at the expense of forest and cut-over land, on the one hand, and of pasture, on the other hand. During recent years the increase has been mostly at the expense of improved pasture. The area of other uses and waste has been practically constant, while the area for cities, farmsteads, roads, etc., has increased, this increase is probably offset by the decrease in area of waste land.

per acre probably decreased also, since the pasture land put into crops was undoubtedly the best pasture.

The growing scarcity of land available for grazing is reflected in the statistics of livestock. The per capita number of livestock in 1922 was less than two-thirds that in 1894 (fig. 21). This was largely caused by decreases in the per capita numbers of sheep, beef cattle, horses, and mules. The expansion of the livestock industry across

[20] This result was obtained by tabulating the acreage of improved and of unimproved land other than woodland separately for the counties originally forested and for those originally covered mostly with grass or desert vegetation. The increase in crop land harvested in each decade, less the increase in improved and unimproved land in forested counties, is assumed to indicate roughly the net loss in pasture area for the decade. To whatever extent these forest areas were formerly pastured before clearing, to that extent the loss in pasture acreage was greater than the figures indicate. However, the carrying capacity of woodland is so small that to allow for it on an acreage basis would be misleading.

the central and far West between 1850 and 1900, and its stationary condition since, are shown in Figures 22 to 29.

TRENDS OF TOTAL AND PER CAPITA NUMBERS OF LIVESTOCK, UNITED STATES, 1850–1922.

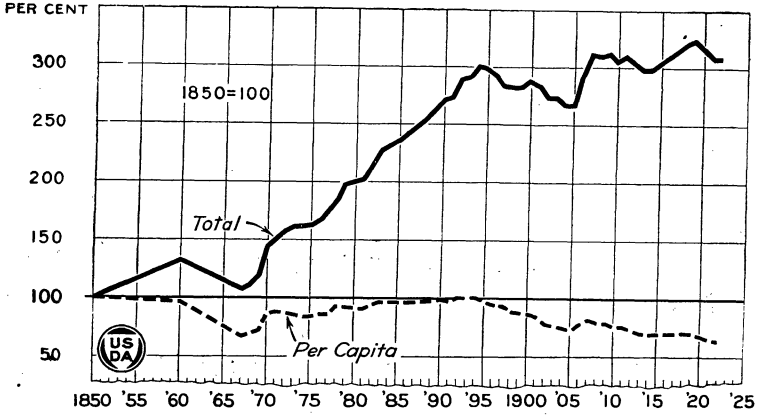


FIG. 21.—Since about 1894 there has been but little increase in the total number of livestock in the United States, and consequently the number per capita in 1922 was only about two-thirds that of 1894. In order to reduce the different classes of livestock for any given year to a single figure, the number of head of each class was given a relative weight equivalent to its 56-year average price. The curve probably contains a certain margin of error due to defects in basic statistics, as revealed by the sudden variations from trend shown at certain periods, as, for instance, between 1906 and 1907.

Increasing Land Values as an Indication of Increasing Scarcity of Farm Land.

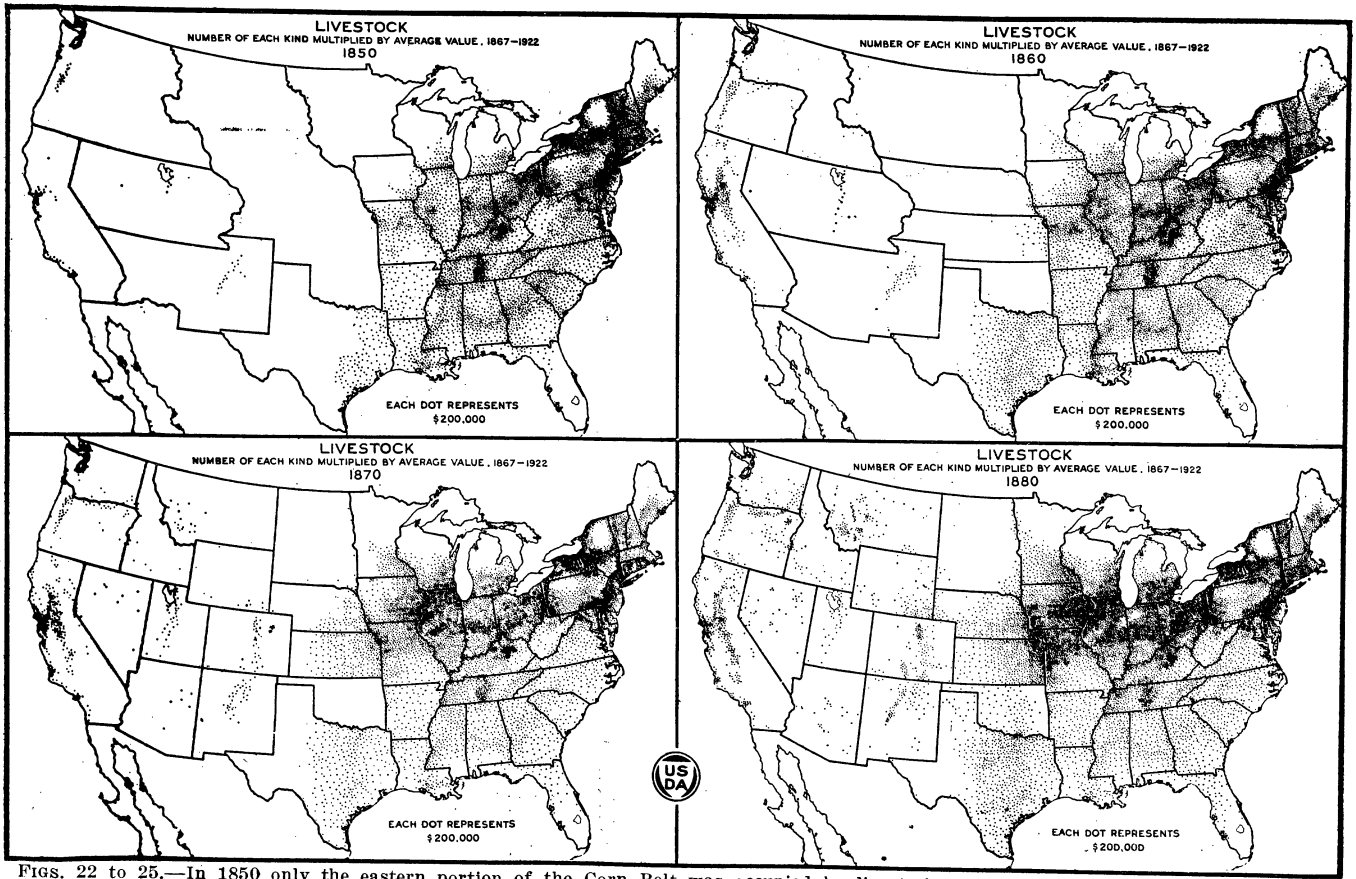
An increase in the average valuation of land per acre is not a conclusive proof of the increasing scarcity of land in a particular country. It may be a result of other influences, such as a decrease in the rate of capitalization or influences outside of the country affecting the world market. Again, an increase in average valuation per acre for the country as a whole may reflect the influences of the addition of new cheap lands in the process of expansion. However, changes in land values may tend to confirm other indications.

The trend in the value of farm real estate per acre from 1850 to 1920, according to the decennial census, is shown in Figure 30.[21]

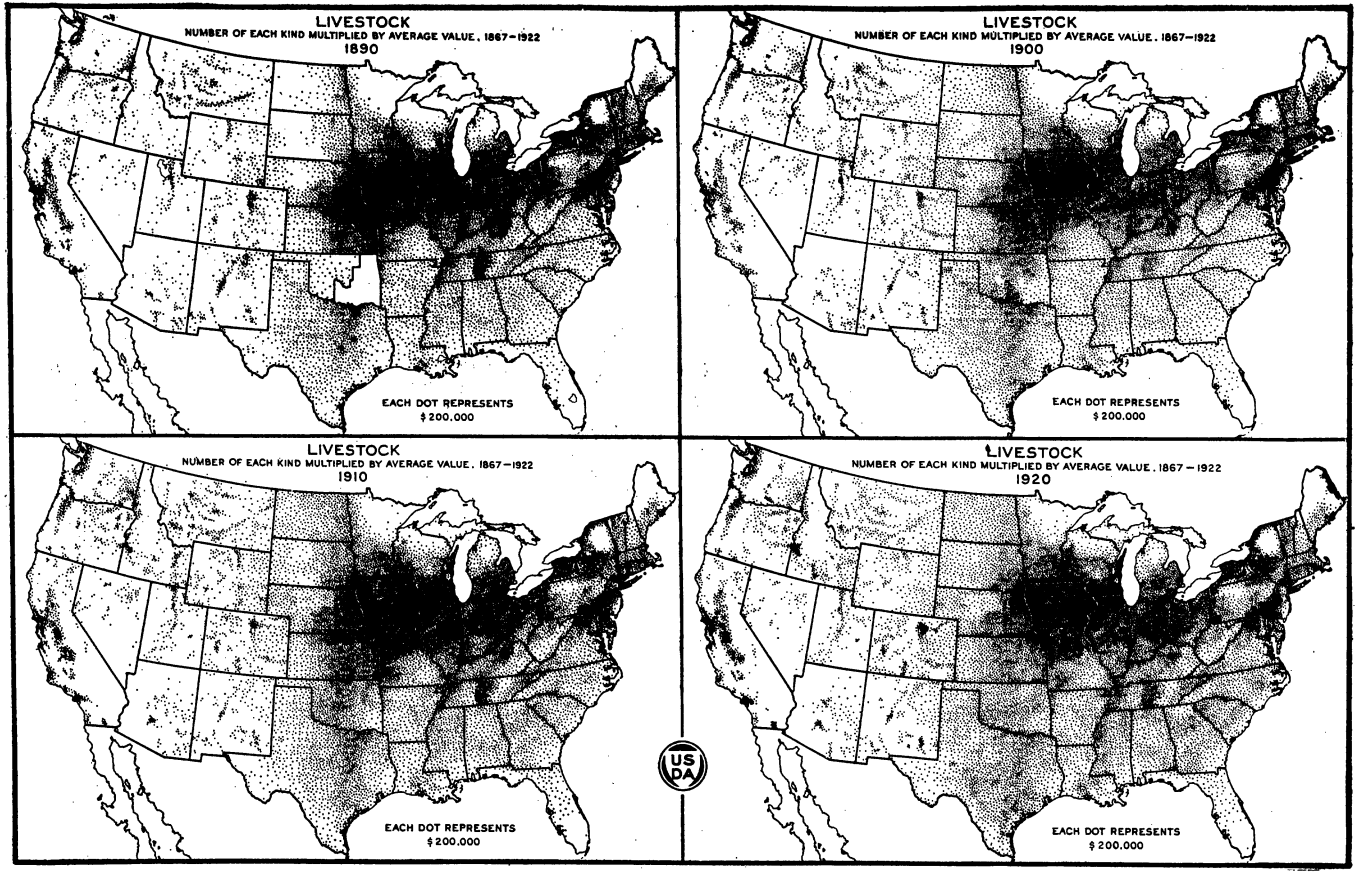
When land valuation is expressed in current dollars without reference to changes in the value of the dollar itself, without regard to the relationship between the valuation of land expressed in dollars and the valuation of other commodities expressed in dollars, it appears that the valuation per acre of farm land has increased during every decade except from 1890 to 1900. This upward trend has occurred in spite of the fact that each decade has seen included in the land area of the nation a large acreage of new and cheap farm land.

However, when the valuation of land per acre is expressed in current dollars, the upward movement may reflect merely inflation

[21] Compare also article "Farm Ownership and Tenancy," p. 541.



FIGS. 22 to 25.—In 1850 only the eastern portion of the Corn Belt was occupied by livestock, and that sparsely, and only a beginning had been made in the extreme southern part of the great dairy States, Wisconsin and Michigan. There were no livestock reported in Iowa, except the extreme eastern part, nor in Minnesota, the Dakotas, Nebraska, and Kansas. A beginning had been made in eastern Texas. Between 1850 and 1880 the Corn Belt, the southern parts of the Great Lakes States, Texas, and the more desirable parts of the Pacific coast and the Rocky Mountains were largely occupied by livestock, but little progress had been made in the Dakotas and Oklahoma, and the vast arid range lands of the western half of the United States were only partly utilized.



FIGS. 26 to 29.—Between 1880 and 1920 the principal extensions in the territory occupied by livestock were the Dakotas and Montana east of the mountains, the western third of Texas, and Oklahoma. Most of this increase was between 1880 and 1890. Between 1890 and 1920 there appears to have been some decrease in the quantity of live stock in much of the Corn Belt. In this series of maps (figs. 22 to 29, inclusive) the various classes of livestock are converted to a single unit of measurement, based on the average values of 56 years, in order to show the expansion of the livestock industry considered as a whole. The statistics were compiled by Dr. Sewell Wright, Bureau of Animal Industry.

of the currency and be a part of a general increase in the prices of all commodities. When we divide the average valuation of farm land per acre by the index number of prices of all commodities (land not being included), we get a rough measure of the changes in the value of land; that is, of the purchasing power of land in terms of other commodities. The figures thus calculated indicate a decrease in the average value of land per acre during three decades since 1850: 1860–69, 1890–99, and 1910–19.[22]

The average figure for the nation as a whole is complicated by the continuous inclusion of new land. A more significant indication of the trend is that available for Ohio by years (fig. 31). This curve

AVERAGE VALUATION PER ACRE OF FARM REAL ESTATE, UNITED STATES, 1850–1919.

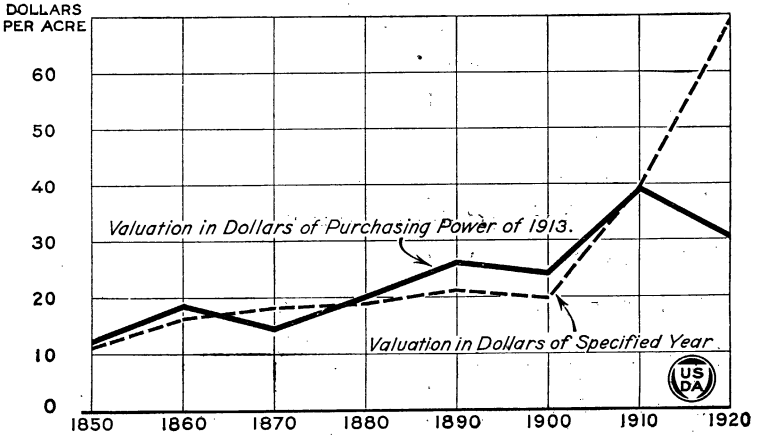


FIG. 30.—The general trend of the valuation of farm real estate has been upward since 1850, so far as it is revealed by decennial census figures. The upward movement was especially rapid from 1900 to 1920, but from 1910 to 1920 the increase in the valuation of land was not as rapid as the upward movement of general commodity prices. Consequently the valuation of farm land expressed in dollars of the purchasing power of 1913 decreased. This decrease was largely due to the tendency for the movement of land values to lag somewhat behind the movement of general commodity prices.

shows the strong upward movement beginning about 1900, but it also shows a slight downward trend preceding 1900.

The trend in the value of farm land up to 1920 appears to confirm the conclusion, supported also by other facts, that the nation reached and passed the apogee of agricultural land supply in proportion to population about three decades ago, and that we have entered a period which will necessarily be marked by a continually increasing scarcity of land. For, although the present area of land in farms is only about one-half the total land area of the United States and the improved farm land is only about one-quarter,

[22] In this last decade the relationship was abnormal, because the prices of commodities had been moving upward with great rapidity while the valuation of land, being apparently slower to respond to the influence of inflation, had tended to lag behind. Consequently the decrease shown from 1910 to 1920 may be only a nominal decrease due to the taking of the statistical picture at a time when the valuation of land had not yet caught up with the upward movement of commodity prices.

nearly all of the area suitable for agricultural purposes is now in use either for crops or for pasture, or is forest and cut-over land, and was probably so employed at least three decades ago. The needs of the increased population, which are two-thirds greater than they were three decades ago, have been met in recent years by a large increase in the total though not in the per-capita area of crop land, mostly at the expense of pasture; and by a decrease in the per-capita area required to maintain livestock, principally due to reductions in the per-capita number of sheep, beef cattle, and horses and mules.

TREND IN AVERAGE VALUATION PER ACRE OF FARM REAL ESTATE IN OHIO COMPARED WITH TREND OF PRICES OF WHOLESALE COMMODITIES IN THE UNITED STATES (DEPARTMENT OF LABOR INDICES), 1877–1921.

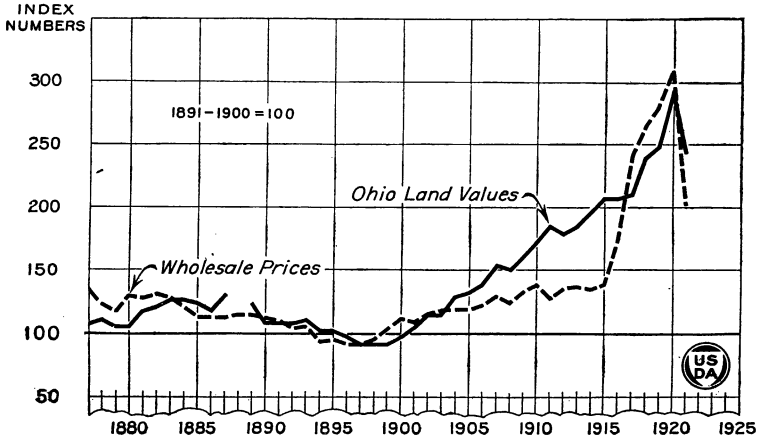


FIG. 31.—Unlike the curve of land valuation shown for the United States as a whole in Figure 30, the curve for Ohio does not reflect the influence of the development of large areas of new farm lands within the State, for Ohio was fully settled before 1877. Instead of an upward movement in the curve of real estate prices throughout the period, as was shown for the United States as a whole, the curve for Ohio follows the downward movement of commodity prices from the eighties to about 1897. From about 1903 to the outbreak of the World War, the curve of real estate prices advanced more rapidly than the curve of commodity prices. This was apparently a period when the value, as distinguished from the price, of land was increasing, probably reflecting the growing scarcity of available farm land of good quality.

Conditions That Tend to Obscure the Increasing Scarcity of Land Resources.

The trend toward increasing scarcity of land resources available for crops, pastures, and forests has been obscured temporarily by the existing agricultural depression and by the fact that we are still cutting our timber largely from a stored crop.

The Overdevelopment of Farm Production for Export Temporarily Disguises the Increasing Scarcity of Farm-Land Resources.

It seems incongruous to talk of the increasing scarcity of land available for crops, pastures, and forest at a time when certain important farm products are almost a drug on the market. Since this

TREND OF NET EXPORTS OF 10 PRINCIPAL CROPS (COMBINED ON BASIS OF 43-YEAR AVERAGE PRICES), UNITED STATES, FISCAL YEARS 1891–1922.

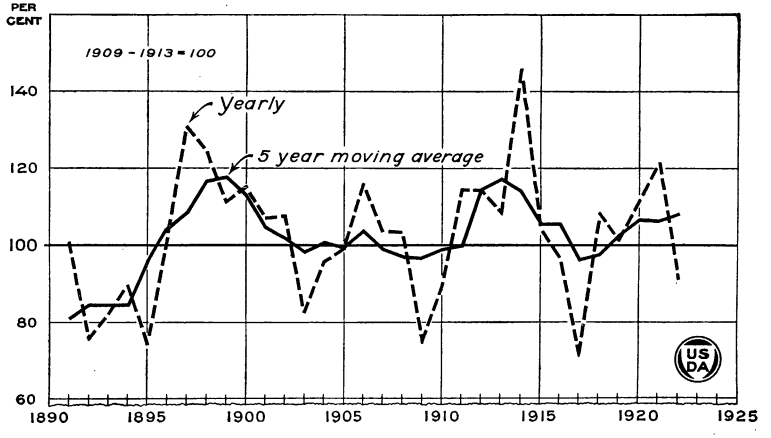


FIG. 32.—The annual variation in the volume of exports is shown by the dashed line, while the solid line is a 5-year moving average centered on the middle year, except for the last two years, which represent 4-year and 3-year averages, respectively. A comparison of the two curves indicates that about 1897 there began a rapid decrease in the volume of exports, which continued until 1903. While the large exports of 1906 were an exception to the downward movement, the general trend appears to have been toward lower averages until 1910. Then began a general upward movement which continued until the outbreak of the World War, followed by a downward movement, which continued until 1917, followed by another increase, which continued until 1921. In general, the level of exports from 1912 to 1922 was higher than in the period from 1902 to 1911.

depression made its appearance, public attention has associated it with the export surplus of farm products. At first the public noticed that the exports of farm products measured in dollars had

TREND OF ACREAGE, PRODUCTION, AND NET EXPORTS OF WHEAT, TOTAL AND PER CAPITA, UNITED STATES, 1909–1922.

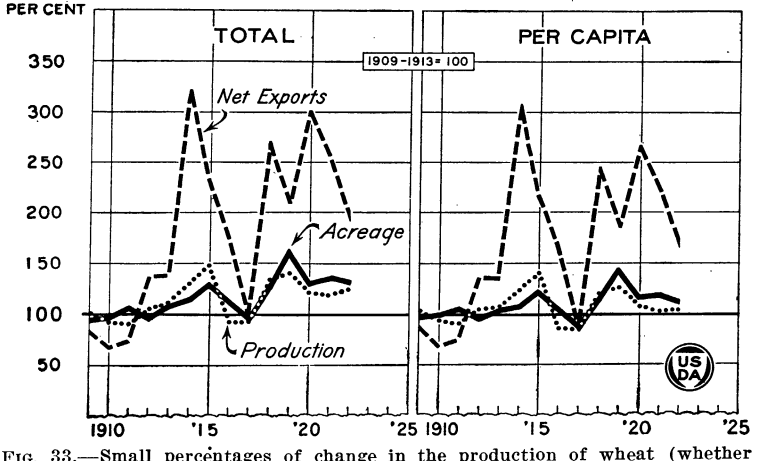


FIG. 33.—Small percentages of change in the production of wheat (whether due to variations in acreage or in yield) result in large percentages of change in exports. The general trend of acreage, production, and exports of wheat was upward from 1910 to 1914. There followed a decline until 1917, and then a marked upward movement culminating in 1919 for acreage and production and in 1920 for exports. From 1920 to 1922 there was but little change in wheat acreage or production, but a large decrease in exports.

decreased. There immediately resulted the impression that our exports were being dammed up in this country because the normal channels of outlet were blocked by the chaotic conditions of credit and international exchange. Subsequently, however, attention was directed to the fact that our physical exports were still much larger than in the pre-war period, and the conviction has developed that the trouble is due to an excessive production of agricultural products.

In order to make clear the fundamental conditions responsible for the development of the present depression and for its continuance, it is necessary to answer certain basic questions: (1) In what degree is the physical export volume of farm products abnormal? (2) What conditions are responsible for the expansion of our exports; is the

TREND OF ACREAGE, PRODUCTION, AND NET EXPORTS OF CORN, TOTAL AND PER CAPITA, UNITED STATES, 1909–1922.

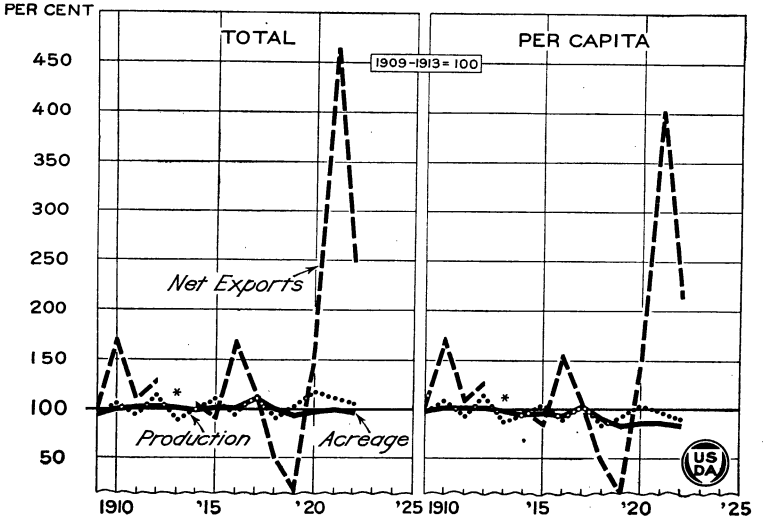


FIG. 34.—The illustration shows the enormous relative expansion in the total and per capita exports of corn in 1921. However, the normal percentage of exports to total product is so small that a slight percentage of increase in the total volume of production, due to increase in acreage or yield, may result in a very large percentage of increase in the surplus available for export. This explains the fact that the large rise in the export curves from 1919–1921 does not coincide with a correspondingly large increase in the curves for acreage and production. For 1913 there were no net exports of corn; hence the break shown in the export curve.

expansion due to increased acreage per capita, to increased production per acre, or to decreased consumption per capita? (3) Was the sudden decrease in prices of farm products due to the enlargement of the volume of exports?

Extent to which the volume of exports is abnormal.—The United States has always had a surplus of farm products for export. The trend in volume of this surplus is shown in Figure 32.

The trend in the volume of exports was downward from about 1897 until about 1909, with a slight interruption due mainly to the large exports of 1906. About 1910 there began an upward trend. This upward movement was interrupted by a downward movement from

about 1914 to 1917, followed by another large increase, mainly due to the enlarged exports of certain cereals. The average annual exports of wheat were over twice as great from 1919–22 as in the five years, 1909–13 (fig. 33). Comparing the same periods, the exports of rye, formerly of little consequence, increased from about 1,000,000 bushels to nearly 43,000,000, the direct exports of corn increased from 40,000,000 bushels to 82,000,000 (fig. 34), and the indirect exports of corn in the form of pork products were largely increased. There was also a considerable increase in the exports of tobacco. On the other hand, the exports of cotton since 1915 have been only 50 to 75 per cent of the average exports during the 5-year pre-war period (fig. 35).

The expansion in the volume of exports which followed the outbreak of the World War also corresponded to an increase in the crop acreage devoted to production for export[23] (fig 36). On

TREND OF ACREAGE, PRODUCTION, AND NET EXPORTS OF COTTON, TOTAL AND PER CAPITA, UNITED STATES, 1909–1922.

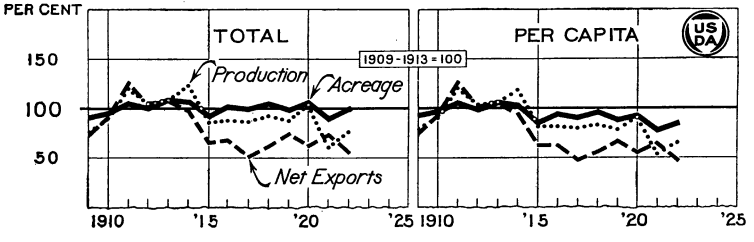


FIG. 35.—While there have been annual fluctuations in cotton acreage, there has been no marked trend either above or below the average for the five years just preceding the World War. However, the per capita acreage has decreased considerably. As a result of this, of the decreased yield due to the ravages of the boll weevil and of the decreased purchasing power of Europe, there has been a notable decline in exports of cotton since 1914.

the basis of 5-year averages the acreage devoted to production for export decreased from the 5-year period 1899–1903 through that of 1909–13, and in the latter 5-year period was only 80 per cent of the average for the period 1899–1903, inclusive. During this period of decreasing exports, there was apprehension that our nation would soon cease to be a net exporter of farm products. However, as a result of the stimulus of war demand, the average acreage devoted to export production for 1919–22 was 40 per cent greater than for the period of 1909–13 and over 13 per cent greater than in the preceding high period 1899–1903.[24]

Conditions which have made possible the increase in acreage employed in producing for export.—One might suppose that the great increase in the volume of cereal exports during the decade 1913–22 was made possible by a sudden expansion of the per capita area of

[23] Calculated on the basis of direct exports.

[24] In the latter half of 1923 there was a marked decrease in exports of cereals and cereal products. If this lower level is maintained during the remainder of the fiscal year, the acreage required to produce these cereal exports will be only about half the annual average 1919–22.

land in crops. However, as already noted, in the period from 1900 to 1922 the trend of crop acreage per capita was downward. In the period 1919–22 the per capita acreage in 12 principal crops was 10 per cent less than for 1899–1903. Furthermore, as pointed out before, the increase in exports was not due to an enlargement of the average yield per crop acre.

TOTAL AND PER CAPITA ACREAGE EMPLOYED FOR DOMESTIC USES AND FOR NET EXPORTS OF 12 PRINCIPAL CROPS, AVERAGE OF 5-YEAR PERIODS, UNITED STATES, 1889–1893 TO 1919–1922.

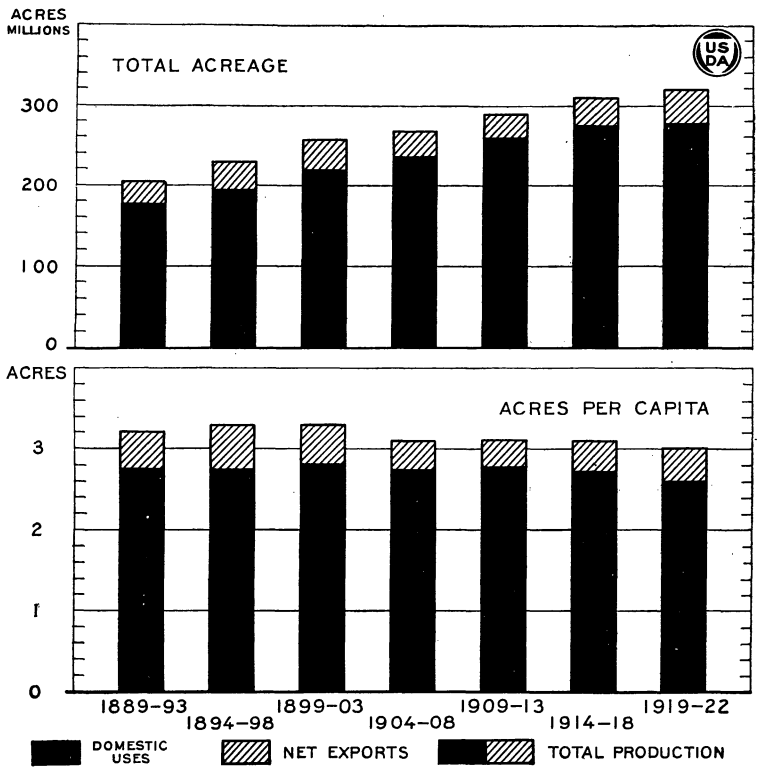


FIG. 36.—The area devoted to these 12 principal crops has increased each decade, but the area per capita was less in the period 1919–1922 than in the period 1899–1903. The area per capita devoted to export production was less in the 1919–1922 period than in the earlier period, but in the 1919–1922 period, the export acreage per capita was a considerably larger proportion of the total per capita acreage than in any period since 1899–1903.

The expansion in the acreage devoted to export production, in spite of the downward trend of per capita crop acreage and the slight decrease in average yield per crop acre, took the form of increase in the area of the cereals, especially wheat, at the expense of other crops. Of the 23,000,000 acres by which the average area of the five cereals for 1919–22 exceeded that of 1909–13, wheat accounted for more than 18,000,000 acres. Most of the remainder is accounted for by increase in the acreage of rye, amounting to more than 100 per cent, together

with a slight increase in the acreage of oats. On the other hand, this is partly offset by slight decreases in the acreage of barley and of corn.[25]

The larger volume of exports made possible by reduction in acreage employed for domestic uses.—Since there has been neither an increase in the per capita area of crop land, nor, as compared with the average for 1903–1907, any increase in the yield per acre either of all the land devoted to crops or of the land devoted to the cereals, it is evident that the expansion in acreage devoted to production for export must have been made possible by a reduction in the acreage employed in producing for domestic uses. After subtracting the acreage devoted to direct exportation of crops from the total crop acreage, the remaining area per capita decreased from 3.15 acres in

TREND OF TOTAL ACREAGE AND PER CAPITA ACREAGE OF ALL CROPS FED TO LIVE STOCK, UNITED STATES, 1909–1922.

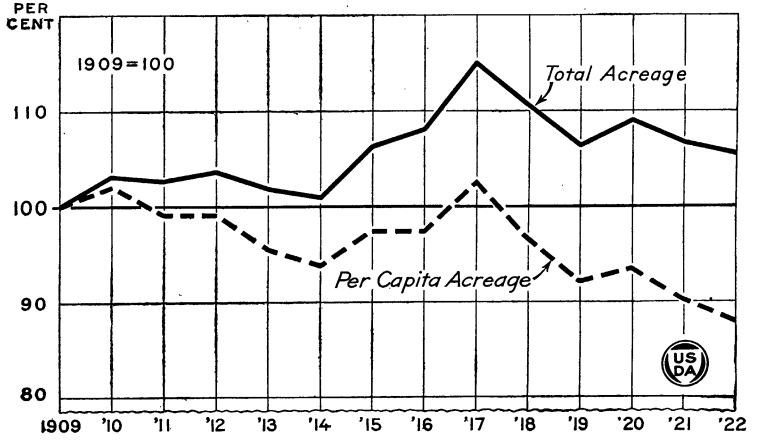


FIG. 37.—The per capita acreage of crops fed to livestock was steadily decreasing from 1910 to 1914. The World War resulted in considerable increase both in total and per capita acreage, but since 1917 there has been a rapid decrease in both regards.

1909–13 to 3.02 acres in 1919–22, or about 4 per cent. When the crop acreage required for the production of livestock and livestock products exported is also subtracted, the per capita area employed in producing for domestic uses decreased from 3.09 to 2.92 acres between these periods; and, finally, when allowance is made for the acreage used to support the horses and mules required to produce the crops and livestock products for export, the per capita acreage employed for domestic consumption declined from 2.99 to 2.82, or nearly 6 per cent.

As noted above, this reduction in the per capita acreage of crops employed for domestic consumption is largely accounted for by the smaller acreage used in producing feed for livestock, made necessary by the increased pressure on the crop area. As a consequence,

[25] Besides the cereal crops, the acreage of tobacco was considerably larger in the post-war period than in the pre-war period, but this is more than offset by a decrease in the acreage of cotton.

the per capita acreage in crops employed in producing feed for livestock decreased from an average of 2.6 for the years 1909–13 to 2.4 for 1919–22 (fig. 37). If the same per capita acreage had been employed in feeding livestock as in the former period, about 22,000,000 acres more would have been required, and this acreage is practically equivalent to the expansion in the area of the cereals during this period.[26]

The diversion of most of the acreage thus economized to increasing the production of wheat and rye was partly the result of the stimuli of the high prices and patriotic appeal of the war period; however, with the passing of these stimuli, the acreage has not returned to normal. The wheat crop of 1920, planted before the fall of prices in the latter part of 1920, was nearly 11,000,000 acres less than the area employed for the wheat crop of 1919; but during the next three years, following the fall of prices, there was no material reduction.[27] Notwithstanding the substantial decrease in wheat acreage in 1920 the acreage planted in 1923 was still 27 per cent larger than the average of the five years before the war. In spite of the discouragements of low prices and unfavorable seasons the farmers, especially in the regions of the Great Plains where there was notable expansion of the farming area mainly for wheat production, have found it difficult to effect a contraction of acreage in wheat. After the range was broken up, houses built, livestock and implements purchased, and heavy debts incurred, it has meant bankruptcy to let the land go back to pasture, and it has been difficult to shift to other crops.

Decreased demand in Europe a factor in causing the surplus of wheat.—It is important not to lose sight of the fact that there is a world market for wheat. It is well known that the war resulted in eliminating Russia temporarily as a large exporter of wheat, and in decreasing the production of other European countries. The increased supply from the United States and Canada was required to help fill this gap. After the war there was no increase in the world supply of wheat or other cereals sufficient to account for the slump in the world price. According to the world balance sheet prepared by the International Institute of Agriculture at Rome, the average annual production of wheat and rye available for the consumption of the world outside of Russia was about 8 per cent less for 1919–21 than for 1909–13. This decrease occurred in spite of an 11 per cent increase in the area devoted to the production of wheat and rye.[28] Yet the price fell far below the war-time average.

The cause of this phenomenon was largely decreased ability of the people of certain European countries to buy as much wheat and rye as formerly at the level of value per bushel which prevailed during the war or even during the pre-war period. Wildly fluctuating exchange rates, unstable currencies, political uncertainties, reduced production, tremendous changes in distribution of wealth, and in

[26] As shown above, these changes are largely the outcome of the reduction in the number of sheep and beef cattle per 1,000 people, and also in the number of horses per 1,000 people due to the substitution of other forms of motive power.

[27] The acreage harvested in 1920 was 14,500,000 acres less than in 1919, nearly 5,000,000 in 1920 not being harvested because of crop failure. In 1923 over 6,000,000 acres were not harvested. The acreage harvested was about 17,000,000 acres less than in 1919 and 3,000,000 less than in 1920, but 11,000,000 acres more than the pre-war acreage, 1909–13.

[28] Yearbook of the International Institute of Agriculture, 1921, p. 65. Since 1921 there has been an increase in world production due largely to the expansion of wheat production in Europe outside of Russia.

some countries protracted unemployment have forced drastic economies even in such vital essentials as the cereals. For instance, the four countries included in Figure 38 were not able to purchase enough more net imports, even at the bargain prices of the past few years, to offset the decrease in their own production.

PERCENTAGES BY WHICH THE COMBINED AVERAGES OF PRODUCTION, NET IMPORTS, AND CONSUMPTION OF CEREALS IN GREAT BRITAIN, FRANCE, GERMANY, AND ITALY DURING THE THREE YEARS 1919–1921, WERE ABOVE OR BELOW THE CORRESPONDING AVERAGES FOR 1909–1913.

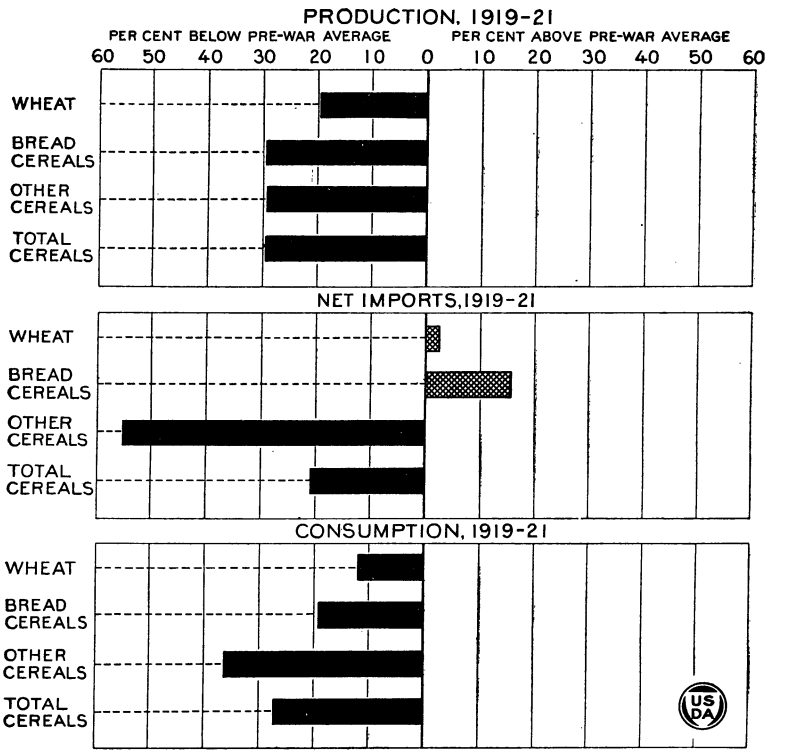


FIG. 38.—The consumption of cereals in the four countries was far below the pre-war average, though the deficit was less for the bread cereals (wheat and rye) than for other cereals; and less for wheat than for rye. After allowing for the slight increase in population, it is evident that in the years following the war the people in these countries were eating only about 80 per cent as much bread cereals and had available for consumption only about 60 per cent as much other cereals as in the years just preceding the war. These deficits in consumption were partly made necessary by the great falling off in production and partly (except in the case of the bread cereals) to the falling off of imports. While the imports of bread grains were somewhat larger than in the pre-war period, this was not sufficient to make up for the heavy deficits in production and in the importation of other cereals.

In short, the interruption in the manifestations of the trend toward increasing scarcity of land in the United States was due partly to a gradual reduction in the per capita acreage of crop land employed for producing livestock for domestic consumption and in maintaining horses, partly to the overexpansion in the per capita acreage of wheat and rye at the expense of the per-capita area in other crops, and partly to a sudden decrease in ability of the Euro-

pean peoples to purchase the accustomed quantity of our wheat and pork at prices which permit a profit to our farmers. Temporarily these conditions have made our available crop acreage appear superabundant.

Some years may be required to restore the normal balance between acreage in cultivation and demand for farm products. The buying capacity of the nonagricultural populations of Europe, reduced by disturbed political and financial conditions and by unemployment, is still not showing signs of immediate improvement; but European agriculture has been steadily recovering and the tendency toward a greater degree of self-sufficiency increasing. Russia may shortly regain a part at least of its former importance as an exporter of wheat. The great increase of wheat acreage in Canada from an average of 9,945,000 acres for 1909–13 to an average of 21,155,000 acres for 1919–23 was accomplished almost entirely by the expansion of the total acreage of land in crops.[29] There has been little tendency to reduce this acreage, in spite of the discouragements of low prices, and there is reason to believe that the greater part of this new Canadian wheat acreage is permanent.

Offsetting this somewhat "bearish" outlook is the fact that the population of the world is increasing at the rate of about 20,000,000 a year, and the population of the United States about 1,500,000 a year.[30] Within a few years the increase in population is likely to bring to an end this temporary deviation from the long-time trend toward an increased pressure of population on land resources. A great war might temporarily cause higher prices, and bad crop seasons in important producing countries might also raise the price level.

The Cutting of Forest Products From a Stored Crop Has Also Obscured the Actual Relation Between Land Supply and Land Utilization.

Since the first settlement of our country we have been cutting our timber from the stored-up product of past years. To use a now familiar expression, our timber supply has been treated as a "mine" instead of as a "crop." Since the original settlement of the country we have reduced our area of virgin timber from an estimated 822,000,000 acres to about 138,000,000 acres. While we have been engaged in cutting from our virgin forests, there has grown up largely spontaneously a supply of second-growth timber, amounting at present to about 122,000,000 acres of saw-timber size and 142,000,000 acres below saw-timber size (suitable for cordwood, ties, posts, etc.). (See figures 1 and 41.) However, we are still cutting timber from our forests at a rate nearly four times the annual aggregate amount of growth of timber. Moreover a considerable part of the former forest area has been devoted to improved farm land; consequently the area of forest has constantly decreased (fig. 39).

The effect of this cutting of our timber mainly from a stored supply is to create while it lasts an apparent abundance of land available for crops and pasture. We are removing the timber from land at the rate of approximately 10,000,000 acres a year, and since we are not deliberately devoting this area to reforestation the surface po-

[29] Yearbook for 1922, International Institute of Agriculture and preliminary estimate for 1923, Dominion Bureau of Statistics.

[30] Tylor, W. Russell. The Natural Increase of Contemporary Peoples. An unpublished doctoral dissertation prepared at the University of Wisconsin.

ACREAGE OF FOREST LAND CONTRASTED WITH ACREAGE OF IMPROVED FARM LAND, UNITED STATES, 1850–1920.

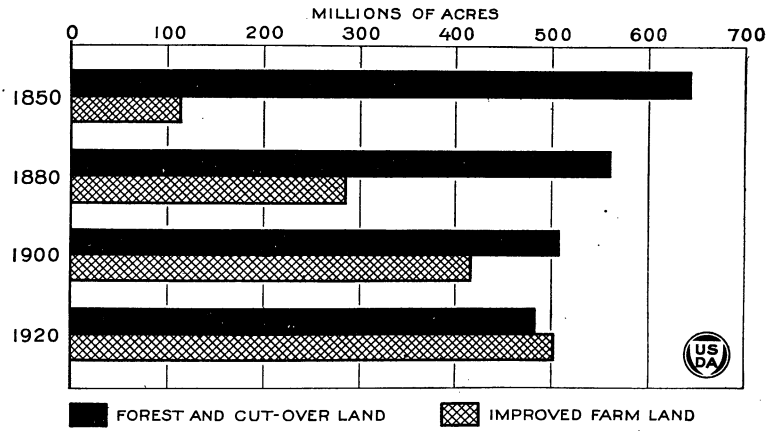


FIG. 39.—The steady increase in the area of improved farm land has been accompanied by a continual but much smaller decrease in the area of forest land. However, less forest land is being cleared for crops or pasture each decade. From 1910 to 1920 only 5 per cent of the increase of "improved" and "other unimproved" land in farms, or about 5,000,000 acres, occurred in forested areas, most of the increase being in the Great Plains region and other grassland areas of the West. (See fig. 16.) At the rate of clearing between 1910 and 1920 it would require several centuries to clear the area of forest which has been cut over during the past 20 years. The figures for improved land are from the census, but the figures of forest area are estimates.

tentially available for the other uses is being correspondingly increased. However, only a small proportion of this area annually denuded is being cleared for crops or pasture. Much of the cut-over area is of poor quality of soil, and the expenses of clearing and in

PER CAPITA ACREAGE OF FOREST LAND CONTRASTED WITH THAT OF IMPROVED FARM LAND, UNITED STATES, 1850–1920.

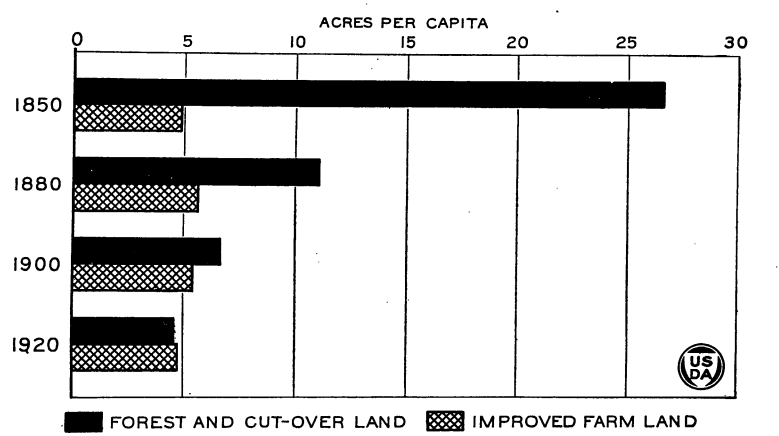


FIG. 40.—The estimated per capita area of forest land in 1920 was about a sixth as large as it was in 1850. The per capita area of improved farm land was nearly the same for the two periods, but it was somewhat less in 1920 than it had been in 1880.

some cases of drainage do not at present justify its use for the production of crops. Theoretically, this land would be suitable for grazing. In some sections, notably in the Lake States, clover and other nutritious grasses thrive. However, the natural pasture is for the most part inferior in those sections of the country where the process of cutting is at present most rapid, as in the South and the Pacific coast. The trees and brush, usually growing more rapidly than the grasses, soon shade the ground, and destroy most of the herbaceous vegetation.

As long as we can depend for our timber on a stored supply, disregarding the advancing prices forced by increasing scarcity, and making no provision for growing new forests, we can get along with a much smaller forest acreage than if we were actually growing a crop of timber to supply our needs. Under this policy of denuding our timberlands we are rapidly reducing the area of land devoted to forests, even allowing for the fact that some of the cut-over forests spontaneously grow a second crop, and some, notably those in public ownership, are managed for continuous growth. The denuded land adds to the already large reserve supply of land potentially capable of being used for crops, pasture, or intensive timber growing but actually not being employed for these purposes.

Such are the conditions which seem to create for the time being a "fool's paradise" of abundance of land resources available for the three important uses under consideration. But we are unquestionably nearing the end of this phase of our economic evolution (fig. 40). If we should be willing to cut our timber supply right up to the last tree, with no provision for the future, we should reach the end of the road within a few decades at the present rate of cutting; for, even allowing for annual growth, our stock of saw timber would hold out less than 50 years, and our stock of smaller timber, only a little more than 30 years. This makes no allowance for any increase in the annual cut due to increasing population, and therefore implies a diminution in per capita consumption.

The advancing prices of timber and timber products due to the increasing scarcity and remoteness of the supply will cause us to curtail our per capita consumption much below the present amount, and will force us to devote abandoned cut-over lands to timber growing, especially in the East. This may result in a sharp competition between timber on the one hand and crops or pasture on the other hand, at least for marginal lands. A large part of the remaining reserve is on the Pacific coast much farther from the present centers of consumption (the Northeast and Middle West) than our former main supplies (fig. 41). Much of our reserve of timber is in rough mountain regions. Long freight hauls and costly logging are resulting in higher prices for timber, and in a gradual reduction of per capita consumption.

Owing to the long time required to grow timber—30 or 40 years for pulpwood and 40 years and up for saw timber—an unnecessarily severe reduction in per capita consumption of timber and timber products and even a near approach to almost complete deprivation can be avoided only by measures that will place our lumber industry on a basis of providing for the replacement by reforestation of timber removed. The growing national pressure toward a definite forest

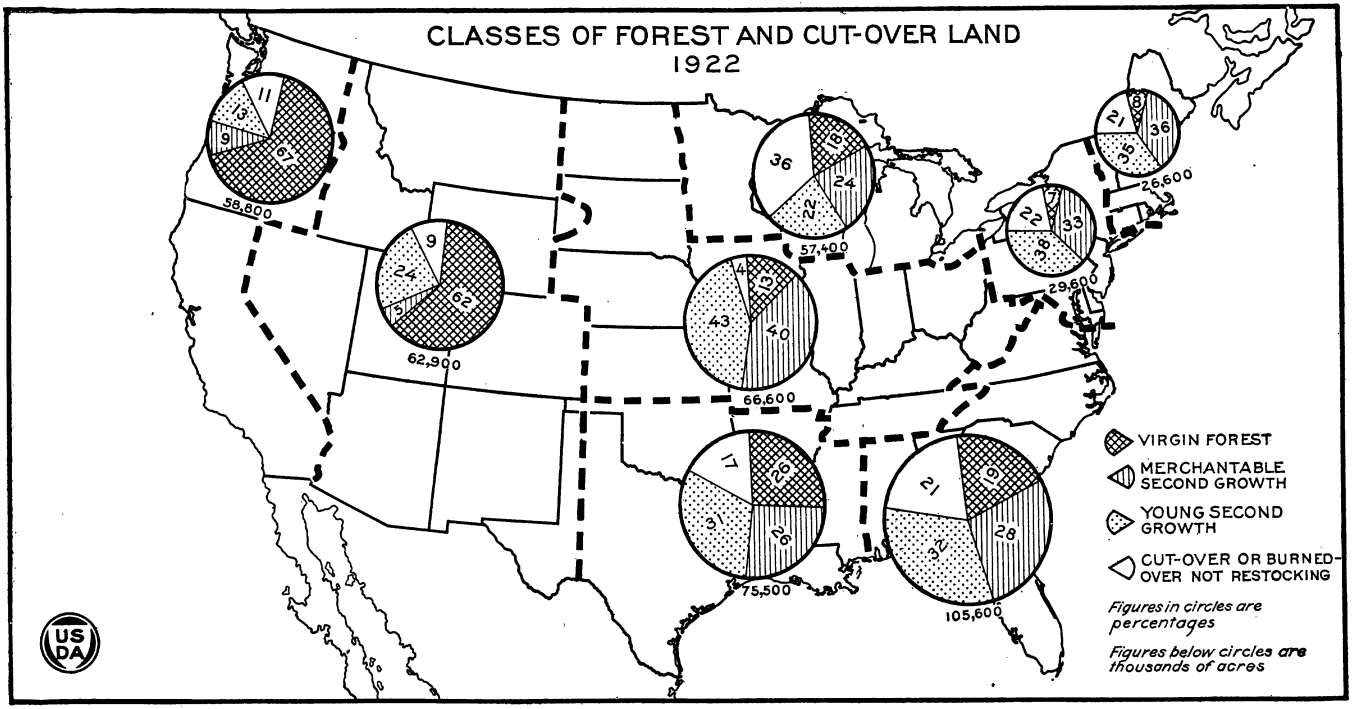


FIG. 41.—In six of the eight regions, all in the East, only about 40 to 53 per cent of the forest area consists of merchantable timber. In these regions the area of virgin timber ranges from 7 to 26 per cent of the total. On the other hand, in the Rocky Mountain and Pacific coast regions the area of virgin timber constitutes about two-thirds of the total. In the Pacific Coast States less than one-fourth of the area is nonmerchantable forest.

policy, and later the tendency toward private timber growing that will be stimulated by rising prices, must be relied on to bring about reforestation. Provisions for growing our timber supply, of course, will tend to reduce the area of idle cut-over land that appears to be available for crops and pasture.

The magnitude of the readjustment that is involved in the inevitable change from the present reliance on cutting from a stored crop to the basis of growing the greater part of our supply may be illustrated by a simple calculation. At the present rate of per capita consumption and waste, and rate of growth in our growing forests, 1,465,000,000 acres would be required to grow timber for a population of 150,000,000 people—more than three-fourths of our entire land surface and about a third more than our entire humid area.

The manifest impossibility of the conclusion emphasizes the fact that we shall shortly find it necessary to make drastic modifications in our rate of consumption of timber, in our rate of growth, or in both. The probable extent of these readjustments and the land requirements involved can best be considered at a later stage of this discussion.

Relation of Foreign Trade to Present Land Requirements.

Before considering the effect of increasing population on our requirements of land for crops, pasture, and forest, it is desirable to determine what proportion of our productive area is employed in production for export; for it is clear that, as our need for land increases, it might be possible to divert to domestic use the products of at least some of the land now employed in producing for export. Furthermore, we may well determine to what extent the importation of agricultural and forest products reduces the amount of land that would otherwise be required to supply existing needs.

Crop Land Required to Produce the Exports of Agricultural Products.

The acreage of crop land employed in producing for export falls into three classes: (1) That which is employed in producing crops for direct export either in the original or in manufactured form, as, for instance, wheat or wheat flour; (2) the acreage used for feeding livestock the products of which are exported; (3) the land required to produce feed for work stock employed in producing for export.

Crop land required to produce the crops directly exported.—Table 1 and Figure 36 show the crop area used for direct exportation, but not that employed indirectly for export production. The 12 crops included in the table occupy nearly 90 per cent of the total area used in crop production, and they represent practically all of the area devoted to the production of crops directly exported. Columns F and G show the remaining crop acreage after deducting the crop acreage employed for crops directly exported.

TABLE 1.—*Total and per capita acreage utilized for total production, domestic consumption, and net exports of 12 important crops of the United States.*

Period.	Production acreage.		Acreage equivalent of net exports.[1]	Acreage equivalent of direct net exports[2] of surplus commodities.		Remaining acreage[3] (employed for domestic uses, including the feeding of livestock).	
	A	B	C	D	E	F	G
	1,000 acres.	*Per capita acres.*	*1,000 acres.*	*1,000 acres.*	*Per capita acres.*	*1,000 acres.*	*Per capita acres.*
Average, 1889–1893	206,668	3.22	29,496	30,055	0.47	177,172	2.76
Average, 1894–1898	231,884	3.27	36,362	36,921	.52	195,522	2.76
Average, 1899–1903	258,372	3.32	38,003	38,550	.50	220,369	2.83
Average, 1904–1908	269,269	3.14	32,002	32,811	.38	237,267	2.76
Average, 1909–1913	291,396	3.11	30,583	33,158	.35	260,813	2.78
Average:							
1914–1918	312,080	3.10	36,874	41,102	.41	275,206	2.73
1919	325,463	3.10	38,102	46,460	.44	287,361	2.74
1920	320,732	3.01	41,839	50,016	.47	278,893	2.62
1921	322,228	2.99	54,336	59,325	.55	267,892	2.48
1922	322,105	2.95	37,352	43,295	.40	284,753	2.61

[1] The 12 crops are corn, wheat, oats, rye, barley, rice, flax, hay, potatoes, cotton, tobacco, and buckwheat.
[2] The term "net exports" is employed not in the sense of total excess of all agricultural exports over agricultural imports, but merely to indicate that in the case of the principal export crops included in the table reductions were made for the comparatively minor imports of the same crops.
[3] This includes the area used in feeding livestock for export.

Crop land required to produce the livestock and livestock products exported.—It is estimated that about 70 per cent of our crop area is employed in feeding livestock. Of the total crop area indicated by the census of 1920, approximately 257,000,000 acres, or 2.43 acres per capita, were employed for this purpose (fig. 37).[31]

Of the total of 257,000,000 acres, the various classes of livestock shared in approximately the following proportions:[32]

	Acres.
Hogs	63,000,000
Cattle	89,000,000
Horses and mules	90,000,000
Poultry	10,500,000
Sheep	4,500,000
Total	257,000,000

In order to ascertain what proportion of the above acreage is devoted to the production of livestock for export, it is necessary to determine the proportion of the various kinds of livestock and livestock products exported in terms of live animals.

The exports of animal foodstuffs from the United States at present are practically confined to pork products and animal fats. During the half decade preceding the war our net exports of pork and pork products were about 11 per cent of the total production. The war demand caused an expansion to a maximum of about 24 per cent in 1919. In 1920 the net exports of pork products were equivalent to 9,100,000 hogs, or about 15 per cent of the total production.

[31] See preceding article, "Our Forage Resources," p. 311.
[32] Based on estimates made from results of a survey by United States Department of Agriculture in 1918, showing farm consumption of feed crops by each class of livestock. See Yearbook for 1920, p. 811.

Up to and including the first years of the twentieth century the United States exported a considerable amount of beef, including live cattle. The exports of beef then steadily declined until, during the half-decade just preceding the war, they amounted to slightly more than 1 per cent of the total beef production. During the war our net exports of beef rose to 4 per cent of the production, but they have been steadily declining since the war, and allowing for net imports of live cattle into the United States, it appears that we are now net importers of beef.

The other meat products produced in the United States have little or no significance in our foreign trade. Our exports and imports of mutton and lamb have been virtually negligible in recent years.[33] We are, of course, largely dependent on foreign sources of supply for wool. The production of veal is comparatively small, and the entire amount produced is consumed in the United States.

The net balance of trade for dairy products before the war showed that the United States was a net importer to the extent of about 0.05 per cent of the national production for 1909–13. Our exports of dairy products increased steadily during the half-decade 1914–18, reaching a peak in 1919. But the volume of exports has since declined, and during 1923 the United States was again a net importer of dairy products.

In brief, the United States is at present a surplus producer in only one important class of animal products, pork products including lard. Since it is estimated that the product of about 63,000,000 crop acres annually is fed to hogs, it appears probable that our average exports of pork and lard for the years 1914–22 (about 15 per cent of the total production) required the employment of about 9,500,000 acres of crops.

The average area from 1914–22 devoted to crops for direct exportation was 39,550,000 acres. Adding to this the above estimate of crop acres used for producing livestock or livestock products for export, we may conclude that our export trade represented in round numbers 49,000,000 acres of crops.

Crop land required to feed the work stock employed in producing agricultural exports.—However, allowance should also be made for the crop acreage required to maintain the horses and mules employed to produce the crops and livestock or livestock products exported. Since about 13.4 per cent of the crop acreage is required to produce the crops and livestock products exported, it would seem fair to assume that an allowance of 13.4 per cent of the 90,000,000 acres required to feed horses and mules should be included in the acreage required to produce the agricultural exports. This would amount to about 12,100,000 acres, making a total of 61,100,000 acres of crop land directly or indirectly used for export production, which is nearly 17 per cent of the total crop acreage, leaving about 304,000,000 acres employed for domestic consumption, on the basis of the acreage of harvested crops in 1919 (fig. 42).

Consequently, if we could devote our total crop acreage to production for our own use we might maintain, on the basis of the crop acreage of 1919, an increase of population amounting to about

[33] The large importation of mutton in 1920 was due to an extraordinary combination of conditions. The English market at that time was glutted with an oversupply of mutton, and favorable ocean freight rates on ships outbound and high prices in the United States were the primary causes of the movement.

21,000,000 people, and that without modifying our standard of consumption.[34]

However, even when the pressure of population on land resources becomes much greater than at present, it is not likely that all the

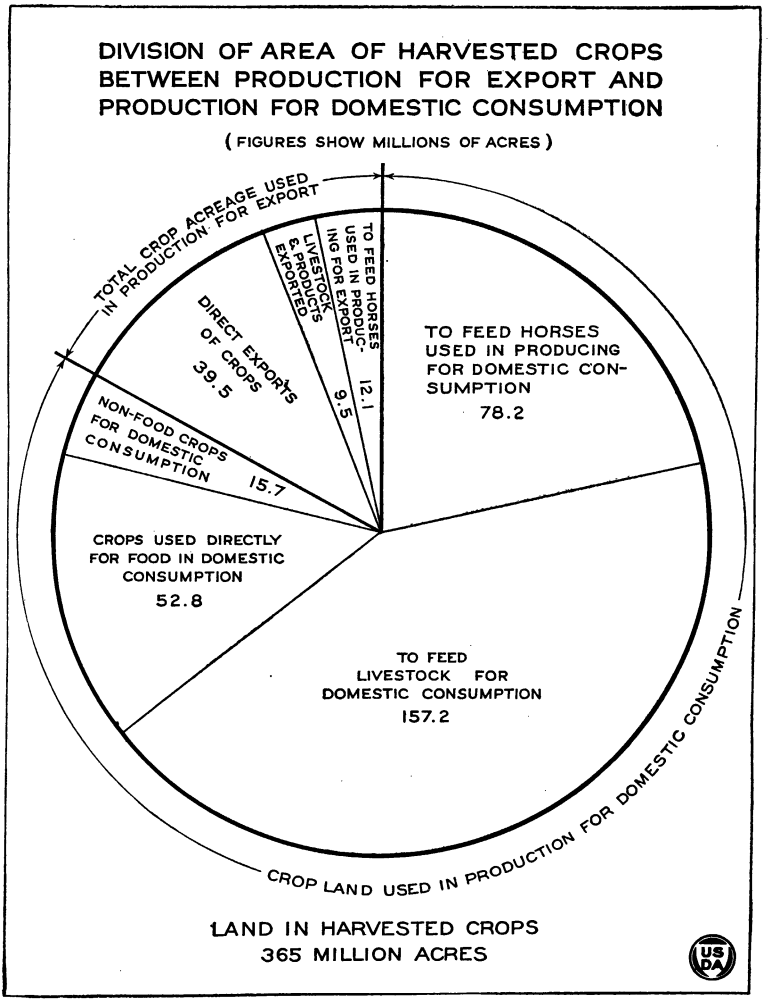


FIG. 42.—While the acreage in crops directly exported was a little less than 40,000,000 in the period 1914–1922, inclusive, account must also be taken of the acreage employed in producing livestock and livestock products for export and in maintaining horses employed in producing for export. Including estimates for these items, it appears that about 61,000,000 acres of harvested crops was employed directly or indirectly in production for export, or nearly 17 per cent of the total acreage of harvested crops in 1919, and a little over 20 per cent of the estimated acreage employed in production for domestic consumption. Of the area used in producing for domestic consumption less than 16,000,000 acres consists of crops not used for feed for livestock or for human food, and allowing for the horses used in producing these crops, about 21,000,000 acres, or less than 7 per cent of the total acreage employed in producing for domestic consumption, were in crops not used for food, directly or indirectly.

[34] This, of course, assumes that we could increase our imports of agricultural products in the same proportion.

acreage now employed in producing for export will be devoted to domestic uses. There are certain commodities for which we have peculiar natural advantages. For instance, we are likely for a long time to produce some cotton for export even if we find it necessary to enlarge our imports of other farm products to make up for the acreage used in producing cotton for foreign consumption. In short, during the next few decades we shall likely divert part of our export acreage to domestic uses, but undoubtedly not all of it unless we restrict severely the importation of farm products.

Relation of imports of farm products to requirements of crop land.—In general, our imports may be considered to economize acreage, but this conclusion involves certain reservations. Some of our imports, such as coffee, cocoa, rubber, and sisal, are practically incapable of being produced in our own country. If we do not import them, our alternative is to do without them. Except as they may serve to replace by substitution other commodities that we can produce, their importation can scarcely be said to economize our land requirements. Certain other articles of importation, such as coconut oil, can not well be produced in this country in considerable quantities, but we can produce close substitutes. Consequently, to all intents and purposes the imports economize the acreage employed for domestic consumption. A large volume of imports consists of commodities, such as sugar, silk, tea, flax fiber, and wool, which, so far as physical conditions are concerned, could be produced in this country, but which are produced abroad more economically. In part this is due to more favorable physical conditions in other countries; in part to more favorable economic conditions, particularly cheaper labor.

All in all, many of our imported agricultural products could be produced in the United States or are substitutes for other things that could be produced here so far as physical conditions of production are concerned. Hence, the importation of these things may be considered to economize whatever acreage of crop and pasture land would be required to produce them or their substitutes. If circumstances required us to provide for complete national self-sufficiency in agricultural production, it would be necessary to add to our per-capita acreage an additional acreage sufficient to make provision for our present imports.

In the calculations of land requirements for domestic consumption attempted in this article, it appears best to assume as constant the present relative dependence on foreign imports. As our population increases, under such an assumption, the total volume of imports would increase in proportion, but the per capita quantity would remain the same.

Total and Per Capita Area of Pasture Employed in Producing Livestock for Export and for Domestic Consumption.

Our only important class of livestock exports—pork and pork products—involves a relatively small use of pasture, and that only of humid pasture. A rough estimate indicates that probably 7,500,000 acres of humid pasture is employed in producing our net exports of livestock and livestock products. This is about 3 per cent of our total area of humid pasture. In addition to this, however,

allowance must also be made for a larger item, namely, the pasture used by horses employed in producing crops or livestock products which are exported, estimated at about 14,500,000 acres (fig. 43).

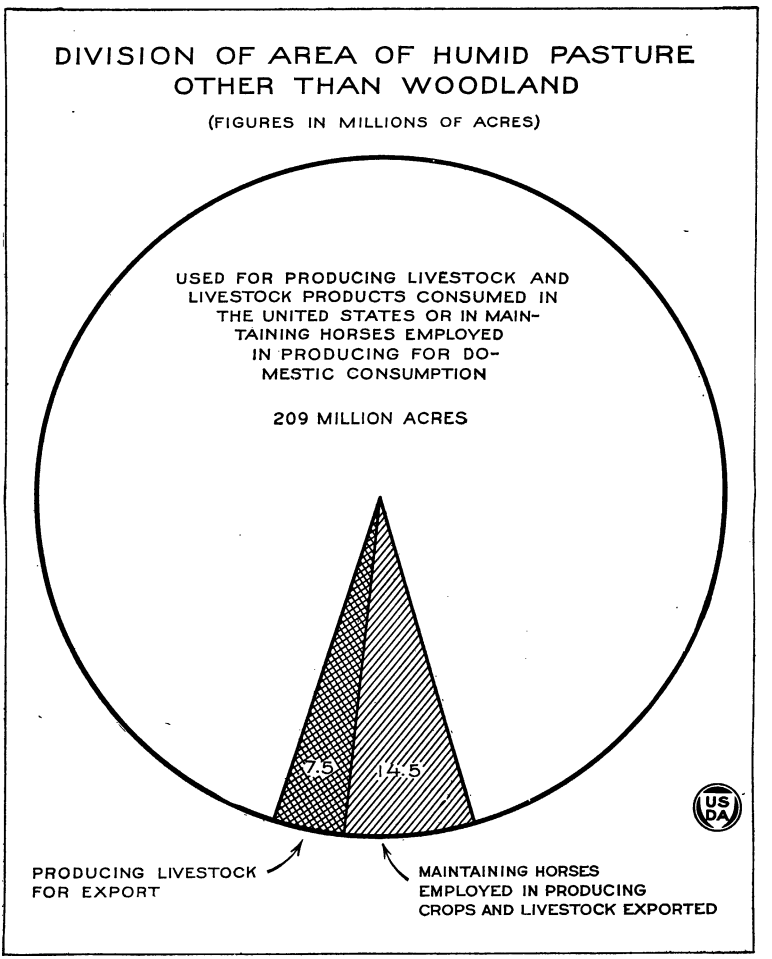


FIG. 43.—The average exports of livestock and livestock products for the period 1914–22 required only a small proportion of our pasture area, and the entire amount has been imputed to humid pasture, because the products exported were essentially the products of humid regions. The acreage of pasture employed in maintaining horses and mules used in producing for export is also imputed to humid pasture, because the semiarid pasture is essentially a limited quantity, humid pasture being the principal variable element in our supply of pasture land. Altogether, about 22,000,000 acres, or less than 10 per cent of the area of humid pasture other than woodland, are employed in production for export.

Relation of Foreign Trade in Forest Products to Land Requirements.

As in the case of pasture, so in the case of forest land, our foreign trade makes but little difference so far as land requirements are concerned. At the present time our exports and imports of forest

products nearly balance one another, and in proportion to the total cut of the United States neither is a large amount. Consequently, it will be fair to assume that the present annual cut measures approximately our national consumption of timber products.

Furthermore, it is believed by students of forestry that we can not hope to rely to a large extent on importation as a means of meeting our needs of timber in the future. This conclusion rests partly on the great costs involved in transporting so bulky a product long distances, and partly on the scarcity of accessible timber in the rest of the world in relation to world needs. The timber consumption of the United States is already nearly half that of the entire world. It is scarcely probable that a large proportion of this consumption could be derived from sources outside this country.[35]

Land Requirements in Relation to Increasing Population.

We have become accustomed in this country to the continued increase of population. Since the decade 1850–1859, when population growth was at the rate of 35.6 per cent, there has been a general tendency toward a decrease in the percentage of increase, although up to 1910 the actual increase was larger each decade. However, from 1910 to 1920 the absolute increase in population was only 13,738,354 as compared with 15,977,691 from 1900 to 1910, and the rate of increase fell from 21 per cent to 14.9.

The restriction of immigration and the uncertainty as to the future policy have complicated the problem of estimating the increase of population. However, it has long been believed that immigration does not add to the population by the full number of immigrants, for immigration appears to retard the natural rate of increase of the native population.[36]

The total population increase of 13,738,354 from 1910 to 1920 included an increase by net immigration of 3,467,000.[37] If this volume of increase were continued during the next three decades, our population would be 150,000,000 people by about the middle of the century. Even the rate of natural increase for the past few years (estimated at approximately 10 per 1,000), without any addition from immigration, would, if continued, result in 150,000,000 people shortly after 1950. The employment of a mathematical formula for projecting population growth on the basis of past experience suggested by Professor Raymond Pearl would indicate a population of 150,000,000 by 1952.

It seems probable, therefore, that we shall have that number of people dependent on our land resources within a few decades, if not exactly by the middle of the century, and it is well to estimate the land required to maintain such a population.

If we should continue to employ for a population of 150,000,000 the same per capita amounts of crop and pasture land as are now

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[35] For more detailed discussion see article, "Timber: Mine or Crop," Yearbook, 1922.

[36] Some students of the subject have even believed the effect of immigration is merely to displace an equivalent number of native population, so that at the end of a given period the native population is smaller than it otherwise would have been by approximately the volume of immigration during the period.

[37] Rossiter, W. S., "Increase of Population in the United States, 1910–1920." Census monograph No. 1, 1922, p. 204.

used for domestic consumption, the land requirements for these two uses would be as shown in Table 2.

The only items that have been varied in the following table as compared with present requirements are crop land and "other humid pasture." The present area of semiarid pasture is practically a maximum that can not be increased to any considerable extent. If anything, it will be decreased somewhat during the next few decades as a result of the encroachment of crop land; but the total reduction in acreage is not likely to be large, and the carrying capacity of this land is so low that the relative reduction in livestock maintained is a very small quantity. Consequently, throughout the subsequent estimates the item is kept constant.

TABLE 2.—*Crop and pasture land that would be required for 150,000,000 people assuming no change in per capita consumption and production per acre, also no exports of agricultural products and no change in per capita imports.*

Use of the land.	Area.
	Acres.
Crop land	431, 000, 000
Woodland pasture	237, 000, 000
Other humid pasture	[1] 336, 000, 000
Semiarid pasture	587, 000, 000
Total	1, 591, 000, 000

[1] As a result of assuming the acreage of semiarid pasture and woodland pasture to remain constant, the area of other humid pasture is increased in greater proportion than the increase of population.

The same practice has been followed with respect to forest and cut-over pasture. If we knew what areas of land will be in forests 30 years from now it might be easier to determine the probable increase or decrease in the area of woodland pasture. According to the present trend, the area of forest land appears to be decreasing. However, most of the area of forest reduced by cutting will be either reforested or will be suitable only for grazing. In either case woodland pasture is potentially land that is likely to be continuously employed for grazing. Moreover, its carrying capacity is so low that a large increase or decrease in area does not result in a very marked modification of the number of livestock that would need to be provided for by other kinds of pasture.

It has already been noted that if the present policy continued the area of land in forests, beginning with approximately 402,000,000 acres of standing timber, will rapidly diminish until the point of approximate exhaustion is reached. On the other hand, if we wish to provide enough forest land to grow our timber, a much larger quantity of land will be required; at the present rate of growth and of waste and consumption per capita the enormous area of 1,465,000,000 acres would be needed for a population of 150,000,000 people. The impossibility of such an outlook is emphasized by combining this area with the 1,591,000,000 acres of crop and pasture land which, as shown above, would be required under similar assumptions. The total resulting requirement would be 2,819,000,000 acres after allowing for duplications, or about 48 per cent more than the present land area of the continental United States.

The result suggests that if we are to maintain our present degree of self-sufficiency, for a population of 150,000,000 we must increase

the average production per acre of our crop, pasture, and forest land, effect marked reductions in per capita consumption of farm and forest products, or make changes in both regards. Therefore, some consideration of the probable extent of these changes is important; not only because of the significance of the changes, but also on account of their bearing on land requirements for the several uses.

Economy in Land Requirements Through Increase of Yield Per Acre.

Crop Land.

In the past our agricultural progress has been largely by way of economizing in the use of labor, rather than in the use of land, by substituting machinery and other labor-saving devices for man power. The great progress in productivity per man is indicated in Figure 44. Since 1870 the product per unit of man labor appears

TRENDS OF TOTAL POPULATION, OF NUMBER OF PERSONS ENGAGED IN AGRICULTURE, AND OF AGGREGATE VOLUME OF PRODUCTION FOR 10 PRINCIPAL CROPS, UNITED STATES, 1870–1920.

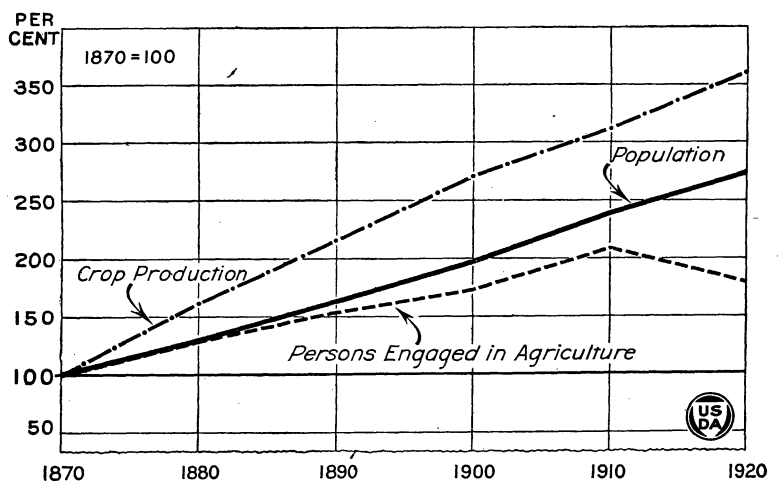

FIG. 44.—The chart indicates that the ratio of population to crop production has not changed greatly since 1880, but that since 1870 the volume of crop production has increased much more rapidly than the number of persons engaged in agriculture. In fact, in 1920 the index of crop production was more than double the index for persons engaged in agriculture. Some allowance should be made for the fact that the date of the census was changed from April 15 in 1910 to January 1 in 1920, a time of year when the number of persons reported as engaged in agriculture is likely to be a minimum. However, it seems clear that the amount of crops per capita and the amount per man engaged in agriculture were both considerably larger in 1920 than in 1870.

to have approximately doubled. It is true, we must not reckon this as an exact measure of increased efficiency. Much of the labor saved in agriculture by using machinery is offset by the employment of labor in cities in producing the machines or represents the transfer to cities of various lines of production and services formerly carried on in the country.

Some progress has also been made in yield per acre (fig. 45). Between the 5-year periods 1883–87 and 1903–07 the average acre yield of nine important crops increased about 19 per cent; but between the latter date and the 5-year period 1918–22 there seems to have been a decrease, so that in the last-mentioned period the average yield per acre was a little over 16 per cent above that of 1883–87. This is small compared with an apparent increase in the productivity of man labor since 1870 of about 100 per cent.

INDEX OF YIELD PER ACRE OF EACH OF SIX IMPORTANT CROPS AND COMBINED INDEX OF NINE IMPORTANT CROPS, BY 5-YEAR AVERAGES, UNITED STATES, 1883–87 TO 1918–22.

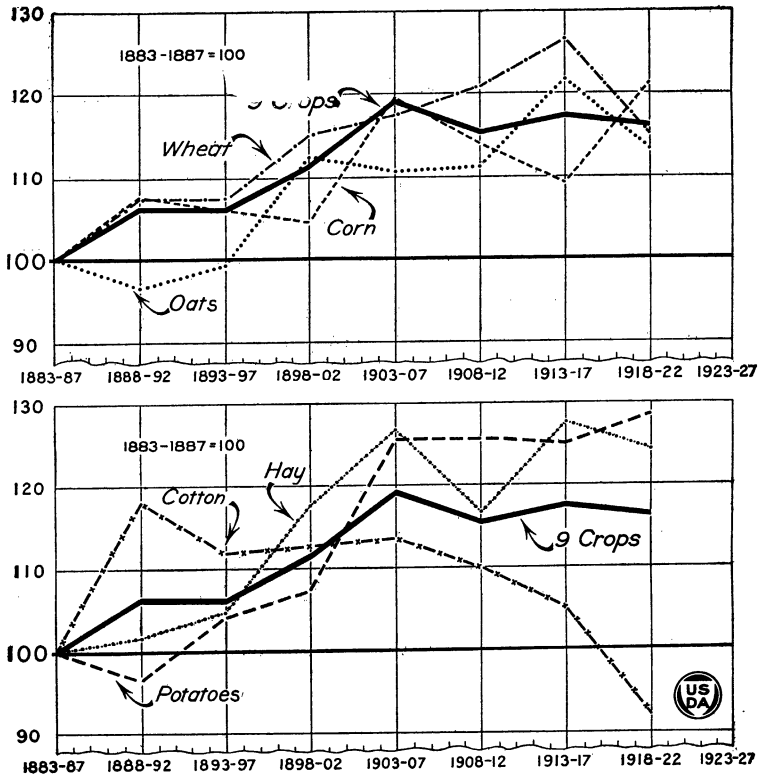

FIG. 45.—The five-year average yield per acre was higher in 1918–22 than in 1883–87 for all of the six crops except cotton. However, the average yield for 1918–22 was lower than it was in 1903–07, not only of cotton but also of wheat, oats, and hay. The composite curve for nine principal crops, shown by the heavy black line, also indicates a slightly smaller average yield in 1918–22 than in 1903–07; though about 16 per cent above the average yield for 1883–87. The composite curve was made by weighting the yield of each crop by its relative acreage in the period 1908–12.

An analysis of the changes in yield per acre of some of the crops making up the above average will be helpful in explaining the trend. The failure of the increase in yield per acre to continue after the period 1903–07 appears to be attributable mainly to cotton and wheat. In the case of cotton the result is probably owing largely to

the boll weevil. In the case of wheat the decrease in average yield is due, in part at least, to the expansion of the crop area onto the less productive lands of our semiarid region. The trend in the yield of corn and oats during the past two decades has been so erratic as to make explanation difficult.

In general, the changes in average acre yields of the several crops must be regarded as the result of a number of forces, some working toward higher yields and others in the opposite direction. On the one hand, we have scientific progress and the more widespread use of improved methods, together with the greater employment of fertilizers; but apparently there has been a tendency for these forces to be offset by the declining fertility of some of our old crop land, by the spread of plant disease and insect pests, and possibly also by the necessity of expanding our crop area by the inclusion of lands of fertility lower than the average for lands formerly employed.

It is important also to reckon with the inertia of large masses of agricultural population, partly due to innate conservatism, partly to lack of information, partly to inadequate capital, and partly to other limiting conditions. Even the development of a most elaborate system of educational extension can not be expected to raise the average yield in practice to the point theoretically possible on the basis of improved methods known to the best agriculturists. Finally, it is probable that because of the comparative abundance of land resources in this country our farmers have not as yet found it profitable to adopt methods of increasing production per acre which require an increased expenditure for labor, fertilizers, and other factors in proportion to the product.

The course of events since the beginning of the World War has appeared to intensify the tendency to economize labor rather than land. The war resulted in the withdrawal of large numbers of farmers and farm laborers for military service or to satisfy the demands for war workers; and for about two years after the armistice the higher relative prices of industrial products, as compared with farm products, continued to place a premium on the withdrawal of labor from farming and to stimulate the employment of extensive, rather than intensive, methods of farming.

Some increase in the productiveness of our land per acre may be accomplished by methods which do not increase, but may even reduce, the cost per unit of product; but it is also possible to increase the productivity per acre largely by increasing the cost per unit of product. The experience of nations has shown that sooner or later the increasing pressure of population forces the employment of the latter class of methods.

Among the most important means of increasing the yields of crops are: (1) The selection of crops better adapted to the available soils; (2) the employment of suitable rotations; (3) the use of better adapted varieties; (4) the reduction or elimination of losses from the depredations of insects and diseases; (5) control of weeds; (6) better or more thorough methods of preparing the land and cultivating the crop; (7) larger or more effective use of fertilizers; and (8) the substitution of crops which give a larger yield per acre for those which give a smaller yield. The first four of these methods may not greatly

increase acre costs, but considerable additional expense is likely to be incurred in weed control, the use of better methods of cultivation, and the increased use of fertilizers.

By the application of these methods what is the outlook for the increase of yield per acre under the influence of increasing pressure of population? There are certain optimists who are fond of taking the results of some striking instances of large yields per acre achieved on a small acreage under highly favorable conditions in perhaps a single year and frequently with little regard to cost as a basis for calculating the total future productivity of the nation. The very statement of the conditions indicates the dangers of this method. It is clearly better to give a great deal of weight to the average results obtained over wide areas by countries which have been compelled by pressure of population to employ intensive methods of cultivation

AVERAGE YIELDS PER ACRE, 1909–13, OF SEVEN IMPORTANT CROPS IN FOUR EUROPEAN COUNTRIES EXPRESSED IN PERCENTAGE OF AVERAGE YIELDS IN THE UNITED STATES.

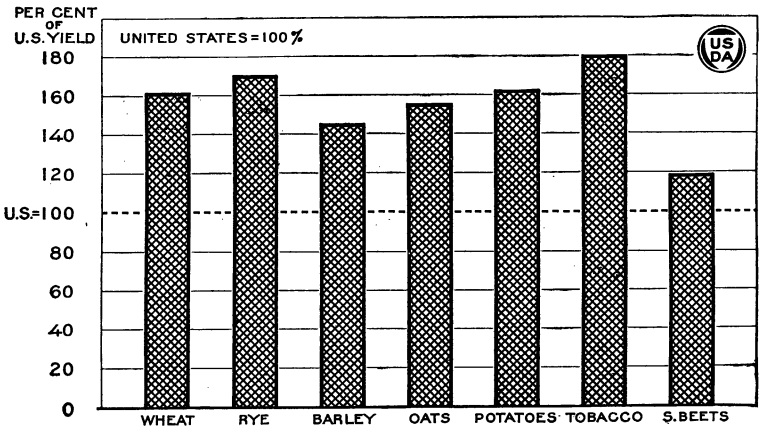

FIG. 46.—The average yield per acre for the four European countries—United Kingdom, France, Germany, and Belgium—is higher than that for the United States in the case of each of the seven crops. The combined average yield for all seven crops, weighted in each case by the relative importance as shown by acreage, is a little over 41 per cent higher for the European countries than for the United States.

and which have employed those methods intelligently and in the light of scientific experimentation, but at the same time with due regard to costs of production. This does not mean that in countries such as Germany and Great Britain, for instance, every farmer is conducting his agricultural operations in the most intelligent and scientific manner. The point is that this is not to be expected. The actual level of practice in any country, no matter how well developed the educational machinery, is certain to be far behind the ideal.

The comparative yields per acre of certain European countries (Germany, France, Belgium, Great Britain, and Ireland) and of the United States are shown in Table 3 and Figure 46.

TABLE 3.—*Average yield per acre of various crops in certain countries, as compared with the yield per acre in the United States, 1909–13.*[1]

Crop.	Yields per acre.						
	Germany.	France.	Great Britain and Ireland.	Belgium.	Average weighted by crop acreage.	United States.	Superiority in yield.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Per cent.*
Wheat	31.8	19.6	31.7	37.6	23.5	14.6	61.22
Rye	29.0	16.6	30.1	35.2	26.6	15.6	70.40
Barley	38.5	25.8	35.3	51.1	34.7	24.0	44.96
Oats	54.9	36.2	50.7	66.1	47.4	30.4	55.96
Potatoes	203.7	127.4	216.2	277.2	157.2	97.0	62.12
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Tobacco	1,713.0	1,231.2	936.8	2,034.2	1,481.0	820.8	80.43
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	
Sugar beets	12.6	10.7	----------	12.3	12.0	10.1	19.28

[1] From Annuaire International De Statistique Agricole (Rome, 1922).

The last column of the above table shows the percentage by which the average yield per acre in the four countries of Europe exceeds that of the United States.[38] If France were excluded the percentages of comparison, as indicating the possibility of expanding our production per acre, would be much greater. It is believed, however, that the inclusion of France gives a figure which represents much more accurately a measure of the possibility of enlarging our production per acre than if the other three countries alone were considered.[39]

Two of our most important crops, corn and cotton, as well as a number of minor crops, are not extensively produced in all of the above countries. Likewise, statistics for hay have not been obtained for all these countries.

Satisfactory statistics for hay production are available for the United Kingdom.[40] The average yield per acre of hay in the United Kingdom for the 5-year period 1909–13 was 1.63 tons. For the same period, the average yield per acre in the United States was 1.34 tons, indicating a higher yield for the United Kingdom of 21.6 per cent. In view of the fact that the climate of the United Kingdom is comparatively favorable for hay production and that special attention has been given to the scientific improvement of the meadows, including a considerable use of fertilizers, it is doubtful if we could safely count on a larger percentage of increase in the American yield per acre.

[38] The productivity per acre of each country is weighted by the average annual acreage for the particular crop during the five years 1909–13, inclusive.

[39] It may be doubted if we could hope to attain so high an average product per acre as obtains in Great Britain, Germany, and Belgium, for a large part of our small-grain crops is produced under semiarid conditions. Some of the European countries, notably Great Britain, Belgium, and Germany, import large quantities of concentrates, which are fed to livestock, and the manure applied to field crops. Moreover, it is wise to allow for the inertia which may retard the general adoption of the most approved agricultural methods in so large a country as our own.

[40] The statistics comprise separate figures for production of clovers, sainfoin, etc., on the one hand, and for hay cut from permanent meadows on the other hand. However, the averages per acre for the two classes are not greatly different, and may be safely combined as a basis of comparison with our own statistics.

With corn, it is difficult to make satisfactory comparisons. There is no extensive area of corn in the more progressive countries of western Europe. Indeed, our production is nearly two-thirds of the production for the entire world, and our average yield per acre is greater than the average yield of the world. In only a few countries is the yield per acre in the United States surpassed, and in a number of these the area involved is so small that it can scarcely be regarded as a fair basis of comparison. Although southeastern Europe is the most important corn-producing section of the world, after the United States, Hungary is the only country in that region with a considerable area in corn which shows a larger yield per acre than that of the United States. Our yield per acre is exceeded by about 40 per cent on considerable areas in Peru and Egypt, but in these countries the crop is mostly irrigated. It is most significant that on about 310,000 acres (mainly in southern Ontario) the Canadians have achieved an average approximately double our own average. It would be a mistake, however, to assume that even if similar methods of production were employed throughout the United States they would produce so high an average, for, corn is raised on large areas of light sandy soils in the Southern States and in other regions, and also under semiarid conditions in considerable areas of the Great Plains. New England, where the climate is not best adapted to corn, shows a 10-year average product ranging from 41 to 47.5 bushels per acre for the various States, as compared with a national average of 26.4 bushels and only 37.3 bushels for Iowa. As in Canada, of course, the product in New England is on a comparatively small acreage. However, Pennsylvania, on an area more than four times that employed for corn in Canada maintained an average of 41.7 bushels.

In view of these facts and considering the great area and diverse physical as well as social conditions involved in corn production in America, it may be doubted whether we shall be able to increase our corn yield per acre above 50 per cent.

In considering cotton we encounter somewhat the same difficulty as with corn, namely, the lack of an adequate basis of comparison. India, which after the United States is the most important cotton-producing country, is characterized by comparatively crude methods of production as well as inadequate rainfall in the regions of cotton production, so that the average product per acre is less than half that of the United States. Egypt, the next largest producer, maintains an average yield of 348 pounds per acre, more than double our average product, but the Egyptian industry is confined almost entirely to irrigated alluvial land of high quality. Brazil maintains an average yield of 258.7 pounds per acre—52.6 per cent above our average. However, the conditions of soil, climate, and types of cotton are all different from those prevailing in America.

As a result of the boll weevil, our average yield per acre for the five years 1918–22 was 22 per cent lower than the average yield for the five years 1888–92. In other words, if we should return to the average acre yield of the former period, we should increase our yield about 28 per cent above the average of 1918–22. This may be regarded as measuring roughly the probable improvement in productivity that might be achieved if we should be so fortunate

as to discover a means of completely eliminating losses due to the boll weevil.

In the absence of a comparative basis for estimating the probable increase in production per acre, and with due regard for the physical and social conditions prevailing in the Cotton Belt and for the fact that on large areas of the poorer land artificial fertilizers are already extensively employed, a further increase of more than 35 per cent would appear doubtful.

We have reached conclusions with respect to the probable increase for 10 important crops, which occupy nearly 90 per cent of our entire crop area. If we weight the percentages by the average area in each of the respective crops for the 5-year period 1909–13, we obtain an average percentage of 46.8, which we may regard as representing the practicable increase in production per unit of crop area when economic conditions shall justify the requisite cost of production.[41]

If this increase in yield of crop land could be achieved by the time our population reaches 150,000,000, we should require for domestic consumption only 269,662,000 acres, about 34,000,000 acres less than we used for domestic consumption in 1920.[42]

This would be a somewhat roseate outlook if it were probable that so large an increase would be made in less than three decades; but when we remember that there has been no increase in average yield per crop acre in the past two decades, so large an increase seems highly improbable. Furthermore, even if it could be attained, it would probably involve a considerable increase in expense per unit of product.

Pasture Land.

The comparison of carrying capacity of pasture in the United States with that of western Europe is beset with great difficulties, for the statistical classifications of pasture land in the various countries differ considerably. The United States is very different from western Europe, by reason of the fact that we employ so large an area of arid and semiarid land for pasturage. Spain is the only country in western Europe which even approaches the United States in this characteristic. It will be better, then, to reserve arid grazing land for separate consideration.

The areas in different classes of pasture and the ratio of livestock units to the total area of pasture are shown for various European countries in Table 4 and Figure 47.

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[41] This involves the assumption, of course, that the remaining 10 per cent or more of crop acreage may be made to show an average per cent of increase in yield equal to that estimated for the 10 crops considered.

[42] The method of estimate was as follows: The acreage now required for domestic consumption was divided into two parts: (1) The acreage used to maintain horses and (2) the acreage employed for other domestic uses. The ratio of the one quantity to the other was determined. The area required for uses other than the maintenance of horses was increased by the ratio of 150,000,000 to the population in 1920, and the resulting quantity was then divided by the ratio of crop acreage required at present for uses other than for the maintenance of horses to the area required for horses. This quotient was then divided by 1.468, in order to allow for increase of yield, and the area required for other crop uses was also divided by 1.468. The two quotients were added to give the estimated crop acreage.

TABLE 4.—*Areas of land employed for pasture and the production of fodder crops and number of acres of pasture per animal unit in various European countries.*[1]

	Natural meadows and pasture land.	Marsh, heath, and uncultivated productive land.	Land sown with grass and other forage crops.	Bare, fallow green manure crops and fields under natural grass.	Total, all classes of pasture.	All classes of pasture per animal unit.[2]
	Thousands of acres.	*Thousands of acres.*	*Thousands of acres.*	*Thousands of acres.*	*Thousands of acres.*	*Acres.*
Germany (1913)	21,211	4,893	8,938	3,642	38,684	1.24
Belgium (1910)	1,280	267	633	22	2,202	0.91
France (1910)	24,866	8,177	12,679	([3])	45,722	2.06
Great Britain and Ireland (1911)	[4] 44,324	([5])	5,837	329	50,490	2.65
Denmark (1912)	761	1,085	2,466	502	4,814	1.46
Netherlands (1911)	2,997	1,268	227	12	4,504	1.60
Total	95,439	15,690	30,780	4,507	146,416	1.81

[1] International Yearbook of Agricultural Statistics, Rome, 1921.

[2] The number of animal units is calculated by the usual method. The livestock statistics from which the animal units are calculated are averages for the three years 1911–13, inclusive, for all the European countries with the following exceptions: All German figures are an average for 1912 and 1913, except that for asses and mules statistics for 1912 only are available; all statistics for the Netherlands are averages for 1910 and 1913; for Denmark the statistics for horses, cattle, sheep, and goats are for 1909, and the statistics of hogs are an average of 1909 and 1914. For Belgium the statistics of sheep and goats are for 1910.

[3] No statistics available or number insignificant.

[4] Includes marsh, heath, and uncultivated productive land.

[5] Included under natural meadows and pastures.

AREA OF HUMID PASTURE (OTHER THAN WOODLAND) PER ANIMAL UNIT, UNITED STATES AND VARIOUS EUROPEAN COUNTRIES.

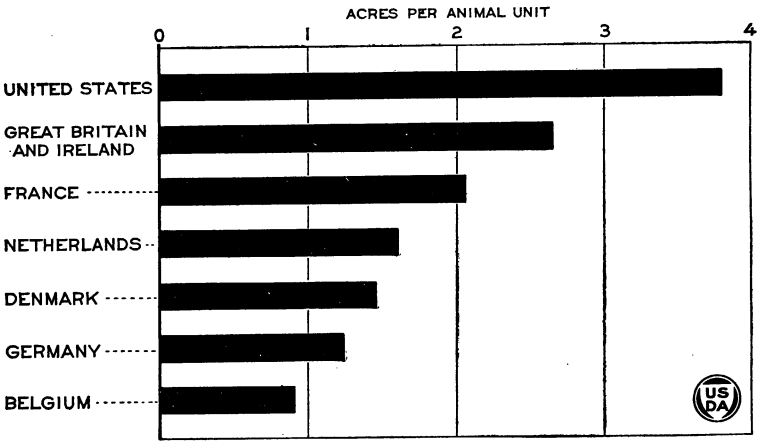

FIG. 47.—The areas of humid pasture per animal unit range from less than 1 acre for Belgium to nearly 4 acres for the United States. However, these differences are not wholly due to differences in carrying capacity, but, to a large extent, reflect differences in the degree of dependence on pasture, as contrasted with other kinds of feed, in the livestock husbandry of the several countries. In calculating the ratios the estimated number of livestock maintained on semiarid pasture and woodland pasture in the United States was excluded, and in all the countries the area of woodland pasture was excluded. To a small extent this makes the comparison unfair to the United States, for the number of livestock carried on woodland pasture in the European countries is not excluded from the calculation. However, because of intensive methods of forestry, the proportion of livestock maintained by woodland pasture in European countries is believed to be very small.

In the six European countries the average number of acres per animal unit is 1.81. On the basis of the estimated acreage of humid pasture in the United States and of the estimated number of animal units in the humid as distinguished from the semiarid parts of the country, there are 4.22 acres of humid pasture per animal unit. This appears to indicate that we employ 133 per cent more acres of humid pasture per animal unit than the average of the six European countries.

The following is a summary of the percentages by which the acres of humid pasture per animal unit for the United States exceed the corresponding ratio for each of the six European countries:

	Per cent.		Per cent.
Great Britain and Ireland	59	Denmark	189
France	105	Germany	240
Netherlands	184	Belgium	364

It will be clear that these differences do not measure differences in carrying capacity of pasture. The pastures of Great Britain and Ireland are probably not greatly inferior in carrying capacity to the pastures of the other countries shown in the table. The differences reflect largely variations in degree of dependence on pasture.

Further light is thrown on the problem by studying comparative figures on carrying capacity for the various kinds of pasture. Through the courtesy of the Prussian Ministry of Agriculture the estimates of the carrying capacity of German pastures, shown in the left-hand side of Table 5, are made available, based on the works of Professor Falke, a high authority on animal husbandry. In the right-hand side of the table are parallel estimates supplied by Professor Hansen, of the Berlin Agricultural High School, a recognized authority on pasture economy.

TABLE 5.—*Estimated average carrying capacity of German pastures.*

Professor Falke's estimate.	Kind of stock and ages.	Professor Hansen's estimate.
Number per acre.		*Number per acre.*
2. 04–3. 33	Cattle of ½ to 1 year	1. 61–2. 70
1. 35–2. 04	Cattle of 1 to 2 years	1. 16–1. 61
1. 16–1. 61	Cattle of 2 to 3 years	0. 90–1. 35
0. 81–1. 61	Cows	0. 68–1. 00
1. 35–1. 62	Horses of 1 year	1. 16–1. 35
0. 90–1. 16	Horses of 1 to 2 years	0. 81–1. 00
0. 81–1. 01	Horses of 2 to 3 years	0. 68–0. 90

In commenting on these figures, officials of the German Ministry of Agriculture expressed the opinion that Professor Falke's figures apply to permanent pastures located in Schleswig-Holstein, East Friesland, Mecklenburg, Pomerania, and East Prussia, as well as to the better pastures in the mountains of Bavaria. Most of these pastures receive some care, and fertilizer is extensively used. On the other hand, most of the mountain pastures do not have so high a carrying capacity. These officials believed Professor Hansen's estimates more nearly represent averages of carrying capacity for all German pastures.

As a result of the study of about 10,000 questionnaires concerning the carrying capacity of humid grassland pasture in the United States, the conclusion has been reached that the average carrying capacity for the usual grazing season (averaging about 6 months) is 2.3 acres per animal unit, or about 0.45 animal units per acre. This excludes woodland and also brush lands and rocky mountain tops. It is true, we have pasture land with a considerably higher carrying capacity. Here and there a township may be found where pasture will carry as much as an animal unit per acre. However, in the American States reporting the highest carrying capacity, the average is but little more than half of an animal unit per acre—that is, less than half the average for all Germany.

According to Professor Hansen's estimate, the average carrying capacity for mature horses and cows ranges from 0.85 to 1.17 animal units per acre. The mean of Professor Hansen's estimates is practically 1 acre per animal unit. On this basis, the carrying capacity of German pastures is about 122 per cent greater than the estimated average carrying capacity for the humid grassland pastures of the United States. Apparently, if we may take Germany as an indication, the superiority of European pasture in productivity as compared with that of the United States is strikingly greater than in the case of crop land.

Data for determining the amount of possible increase in the grazing capacity of our semiarid pasture lands are not yet available. Experiments have been conducted, such as those at the Jornada Range Reserve in New Mexico, where on 200,000 acres an increase of 50 per cent in carrying capacity was effected by a 5-year period of management,[43] and an average increase of 100 per cent in production for each animal unit carried resulted during an 8-year period.[44] Another experiment carried on in southern Arizona resulted in an increased carrying capacity of 100 per cent from five years' management.[45] However, the above were obtained under experimental conditions which are not likely to conform to the broad average of practice. On a much larger scale the experience accumulated on 100,000,000 acres of national forest ranges of the West indicates a general improvement of 25 to 30 per cent through controlled grazing. Of course, these lands are partly humid or subhumid. Nevertheless, it is probable that this experience reflects the possible increase in productivity that might shortly be attained by substituting regulated grazing for the present promiscuous use of open range. It is probable that the productivity of the national forest ranges could be increased another 25 per cent in course of time through the employment of a higher grade of livestock, better care, closer coordination of range forage and other feed, and the further extension of improved principles of range management, such as proper time and intensity of use or "deferred and rotation grazing." On the public grazing lands not now subject to regulation, a conservative estimate of increased productiveness through regulation is 50 per cent. On

[43] See Bulletin 588, United States Department of Agriculture, by J. T. Jardine and L. C. Hurtt—"Increased Cattle Production in Southwestern Ranges."
[44] Computed from unpublished reports in Forest Service.
[45] United States Department of Agriculture Bulletin 367, by E. O. Wooton—"Carrying Capacity of Grazing Ranges in Southern Arizona."

privately owned range lands, it is probable that the potential increase in productivity is much less. Experience has shown that it is a slow process to bring up the average of individual practice. Probably it is not wise to count on an increase of more than 25 to 30 per cent in productivity on the semiarid range pastures not in public ownership.

It is doubtful if the future will see a considerable increase in the carrying capacity of the area of forest and woodland pasture. More than a fourth of it is in national forests already grazed under careful regulation. The remaining area consists largely of cut-over land or second-growth timber. The development of timber-growing in these areas will increase the density of timber stands and reduce the amount of forage, and in many cases may lead to the reduction or exclusion of livestock. Even in the national forests the protection and encouragement of young growth have necessitated the exclusion of livestock in some areas.

The above estimates of possible increase in carrying capacity of pasture are not intended to suggest that we shall actually achieve so high a standard of pasture management in the next three or four decades, for this is highly improbable; but it may be worth while to calculate the area of humid grassland pasture that would be needed for a population of 150,000,000 on the assumption of an increase of 122 per cent increased carrying capacity on humid pastures other than woodland, and 50 per cent on semiarid pastures. This will give at least a conception of the minimum area that would be needed to maintain present standards of consumption. Allowing for these increases and assuming the areas of semiarid and woodland pasture to remain constant (as explained above), approximately only 120,700,000 acres of humid grassland pasture would be required for a population of 150,000,000, as compared with 209,000,000 acres of this type of pasture now employed for domestic consumption. Actually, of course, for a population of 150,000,000 we shall need an area between this minimum of 120,700,000 and a maximum of 336,000,000 acres in order to maintain the present standards of consumption of livestock products.[46]

Forests.

At the present time a large part of the 483,000,000 acres classed as forest and cut-over land is not growing timber. On the 138,000,000 acres of virgin timber it is estimated that annual growth is about balanced by the loss from death and decay; these forests have reached, roughly speaking, a natural balance. About 81,000,000

[46] The above estimate was made as follows: The number of animal units other than work stock required for a population of 150,000,000 people was calculated. The number of horse animal units was estimated as follows: The fraction of a horse animal unit per acre of crop land at present was determined. This requirement was increased by 40 per cent (see p. 478) and the resulting horse requirement per acre was multiplied by the crop acreage required for 150,000,000 people under the assumption of an increase of 46.8 per cent in productivity, as previously estimated. The required number of horse units was then added to the number of other animal units. The estimated number of animal units carried on semiarid pasture, increased by 50 per cent, was added to the estimated number maintained on woodland pasture. The sum was subtracted from the required number of animal units. The percentage of the remainder to the number now maintained on humid pasture other than woodland was then ascertained, and the present acreage of humid pasture other than woodland was multiplied by this percentage.

acres are not restocking because of fire or other causes. On the 264,000,000 acres of growing timber the annual rate of growth is estimated at only 24 cubic feet per annum, a rate only about half that which prevails in well-cared-for forests of certain European countries (fig. 48). As a consequence, the annual growth amounts

RATE OF GROWTH PER ACRE IN GROWING FOREST AREA OF THE UNITED STATES CONTRASTED WITH THAT OF TOTAL FOREST AREA IN VARIOUS EUROPEAN COUNTRIES.

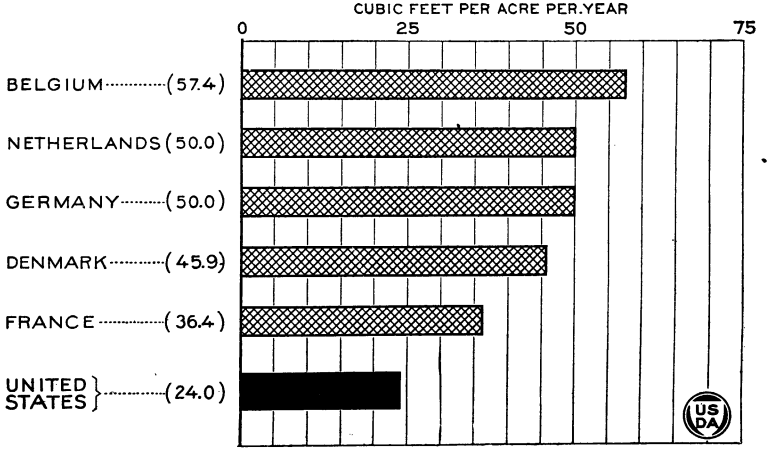

FIG. 48.—The rate of growth of growing forests in the United States is less than half that of Belgium, the Netherlands, and Germany. The rate of growth for the United States is calculated only on the basis of the 264,000,000 acres of actually growing forest, omitting the area of virgin forests and the denuded areas not restocking. On the other hand, for the European countries the total estimated growth is divided by the total forest area, including small areas of denuded land not yet reforested. However, this does not seriously reduce the rates.

to only about one-fourth of the present annual consumption. Our present annual consumption and wastage of forest products is 24,785,000,000 cubic feet per annum. However, of this 2,380,000,000 cubic feet represents estimated loss from fire, insects, diseases, and windfall (fig. 55). Assuming that in the next few decades we shall be able to eliminate this wastage, we should require for a population of 150,000,000 people an annual cut of 31,793,000,000 cubic feet per annum to maintain the present rate of consumption. If we should manage to increase the rate of growth per acre to that which prevails, say, in Germany or the Netherlands, that is, to 50 cubic feet, we should require 636,000,000 acres of growing forest or 32 per cent more than our present forest area including the area denuded and not restocking.

The maintenance of so high a standard of productivity will involve, of course, the intensive application of labor, not only in the careful harvesting of mature timber so as to insure natural reproduction, but also in protecting, thinning, and other cultural operations in the new forest throughout its life. In these respects the cultivated forest of the future will be as different from the wild, volunteer forests of to-day as farm land is from wild land. Protection from fire and reliance chiefly on chance reproduction or on a few seed trees in the more difficult types will not assure this high

productivity; in fact, it is estimated that such measures would increase the annual growth per acre of growing forest from only about 24 to 29 cubic feet.

Owing to the fact that a large part of our forest is in private ownership, we can not expect a rapid development of the most intensive forestry in a short time. The existence of our still large reserve of virgin timber retards the economic forces that would otherwise more rapidly lead to profitable timber growing. In addition, there is much conservatism, traditional apathy, and inertia to prevent as rapid an increase in timber growing as we need. Unquestionably economic forces are being stimulated and traditional obstacles removed by the widespread awakening to the danger of future timber shortage. However, intensive forestry of the European type can not be developed rapidly enough, especially in our privately owned forest lands, during the next few decades to offset this shortage. Even in the lands publicly owned the huge problems involved in fire protection, in administration, and in marketing the less accessible timber retard the development of the most intensive methods of forestry.

Conditions of Increased Productivity Per Unit of Land Employed.

It has already been suggested that the experience of older countries has shown that the increased productiveness per acre required to maintain a dense population is obtained at a greater cost, partic-

NUMBER OF PERSONS EMPLOYED IN AGRICULTURE PER THOUSAND ACRES OF CROP LAND (EXCLUDING WILD HAY), SELECTED EUROPEAN COUNTRIES AND STATES OF THE UNITED STATES.

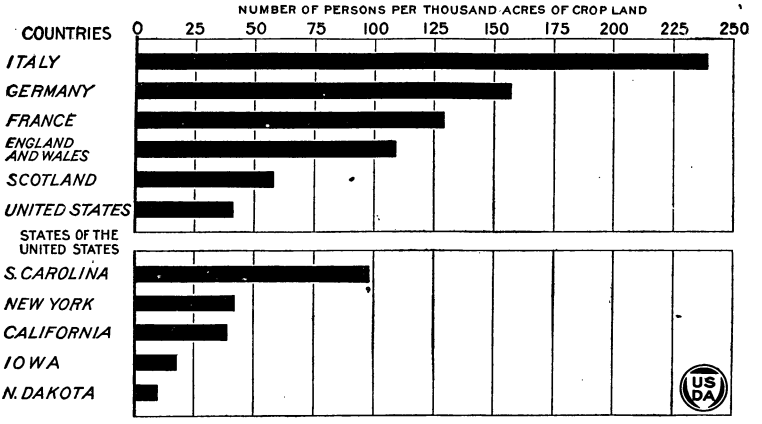

FIG. 49.—The larger yields per acre characteristic of European nations involve a heavy cost in human labor. To some extent the contrasts reflect differences in the character of the crops. Thus the large relative amount of labor in Italy is partly due to the prevalence of such intensive crops as silk, wine, olives, citrus fruits, etc., and in South Carolina to the predominance of such intensive crops as cotton and tobacco. In part, it is due to the smaller number of horses and other work stock per thousand acres in the continental countries, as compared with Great Britain and the United States. In part, also the farm population in the continental countries is employed in domestic industries as well as in farming. However, after all these allowances are made, it is still true that the European nations employ much more labor per thousand acres of crops than is found economical in the United States. For the United States the data are from the census of 1920. For the European countries the latest official statistics were employed.

ularly of labor, not only per unit of land but also per unit of product. It is true, we may effect some increase by a more widespread adoption of improved methods of increasing the productiveness of land without correspondingly increased expense. Furthermore, our progress in saving labor by development of new mechanical devices would offset somewhat the increase in costs involved in more intensive farming; and there is always the possibility of some epoch-making discovery that will revolutionize the possibility of increasing product per acre without proportionately increasing costs.

In spite of these possibilities, it is foolish to underestimate the significance of the fact that the superiority of the agriculture of western Europe in productivity per unit of land, as compared with the United States, is attained by a considerably greater expenditure of labor (fig. 49). As compared with a population engaged in

NUMBER OF WORK ANIMALS PER THOUSAND ACRES OF CROP LAND (EXCLUDING WILD HAY), THE UNITED STATES, SELECTED EUROPEAN COUNTRIES, AND STATES OF THE UNITED STATES.

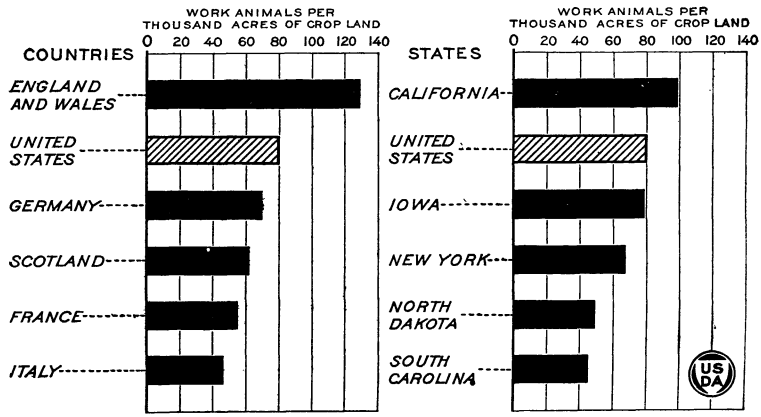

FIG. 50.—While the United States uses more work animals per thousand acres of crop land than the European countries, except England and Wales, the percentages by the United States exceeds the respective countries in this regard are not as large as the percentages by which they exceed the United States in the quantity of labor per thousand acres of crop land (see fig. 49). The number of work stock per thousand acres of crop land in England and Wales is larger than for the United States, but the ratio of work stock to persons engaged in agriculture is smaller. The figures for the United States are based on the census of 1920. For the European countries the latest official statistics were employed.

agriculture, in the United States averaging 41 per thousand acres of crop land, there are nearly 6 times as many in Italy, nearly 4 times as many in Germany, over 3 times as many in France, and more than 2½ times as many in England and Wales in spite of the prevalence of a pasture economy in the last-mentioned country.

Of course, our agriculture is relatively more intensive than a mere comparison of proportions of persons per thousand acres of crop land would seem to indicate; for, in place of some of the persons directly engaged in farming in Europe, we employ some persons in our cities in making a greater quantity of machinery and implements per thousand acres of crop land than are used in European countries. Furthermore, we use a greater number of horses and mules per thousand acres of crop land than are employed in most European countries (fig. 50).

Not only is the superiority of western European countries in yield per acre achieved at the expense of a greater quantity of man labor per acre; but the evidence indicates that the extra expenditure is proportionately much greater than the increase of yield, so that the yield per unit of labor is much smaller than in the United States. Let us take for comparison the four countries—the United Kingdom, Germany, Belgium, and France. Their average product per acre for seven important crops was found to be about 41 per cent greater than for the United States. However, their agriculturally employed population per thousand acres of crop land was 278 per cent greater than for the United States.[47] It is true, they used slightly fewer work horses and mules per thousand acres of crop land than in this country (78 as compared with 80), but this slight difference is almost certainly made up by the proportionately greater use in the European countries of supplementary work animals such as oxen and dogs. Moreover, it is probable that the expenditure for fertilizer per acre is much greater than in the United States.

It may be unfair, therefore, to compare the productivity of the seven crops per unit of human labor in these four countries with that of the United States. On this basis it appears that whereas the yield per acre for the four European countries was 41 per cent greater than for the United States, the yield per person directly employed in agriculture was 159 per cent greater for the United States than for the four European countries.[48]

It does not necessarily follow that in order to increase our average yield per acre 41 per cent, we shall have to increase our number of laborers from 41 per thousand acres of crop land to 155 per thousand acres, or 278 per cent. Our agriculture is organized on the basis of a large number of work stock in proportion to human labor. Thus, in America there are approximately two horses or mules to one agricultural worker. On the other hand, in the four European countries there are two workers to each horse or mule. In short, our present ratio of horse labor to human labor is about four times that prevailing in the four European countries.

This contrast partly grows out of our system of farm organization. Of the four European countries, all but the United Kingdom are characterized by large numbers of small peasant farms which employ horse labor very sparingly.

Our own farm organization is more similar to that of England, involving larger units than prevail on the continent. It will be noted

[47] This is on the basis of the United States census for 1920, which was taken as of January 1, and which showed fewer persons engaged in agriculture by about 1,500,000 than were reported in the 1910 census, which was taken as of April 15. It is believed that the difference in date of enumeration is partly responsible for the smaller number shown for 1920.

[48] It should be recognized that the statistical comparison is a very rough one and should be regarded only as suggestive rather than an exact measure of the differences involved. In the first place, occupational statistics are very inaccurate because the time of year in taking the census makes a considerable difference. Moreover, the proportions of casual labor and of woman and child labor vary considerably in the different countries. Again, the production figures are for only seven principal crops. America produces at least two important crops not grown in the four European countries; and some of these countries in turn lay a greater emphasis on small fruits and vineyard, truck, and other intensive products than is the case in the United States. In some of the European countries a good deal of the time of the agricultural population is employed in by-industries, such as domestic manufactures, or in making things for themselves or performing services for which American farmers have to pay. Finally, it must be recognized that no account has been taken of the relative amounts of labor employed in producing and caring for livestock.

that in England and Wales the ratio of horses to laborers is as 118 to 100. When we have reached the probable extreme of intensity of cultivation our figures both for man labor and for horse labor per acre of crops are likely to resemble more closely the English than the continental ratios. Even this would mean increasing man labor per acre 215 per cent and horse labor 61 per cent.

It is probable that with our aptitude for mechanical devices we shall increase our man labor in somewhat less extent and employ a somewhat greater proportion of horse labor or its equivalent in other forms of power. It is also probable that progress in science and invention will result in more efficient methods of production; but this is not predictable and, indeed, is an immeasurable factor and one that should not be too greatly relied on in making our plans for the future.

It might be said that part of the present superiority of America in productiveness per man is due to superiority in intelligence and skill of our population and that this will make it unnecessary to pay so heavy a price for increased yield per acre as the European countries have paid. However, we have no more right to assume that all or any part of our superiority in production per man is due to our superior efficiency, than the people of the above-named countries have to assume that their superiority in productiveness per acre is due to the same cause. The fact is that a high degree of skill in America is directed to the economy of labor, while in western Europe probably equally as much skill and intelligence are devoted to the problem of economizing land.

The facts point to the conclusion that after a certain average of productivity per acre is attained, probably somewhat higher than that now prevailing in this country, a marked increase in average product per acre is attained only by a much greater expenditure of labor. This may explain why our farmers in the past two decades have made so little progress in production per acre.

The above facts also point strongly to the conclusion that unless the future shall result in exceptional progress in scientific invention and discovery, making possible a larger yield per acre without the corresponding penalties in increased costs now required, we may need to increase considerably the proportion of our population engaged in agriculture; but this change is hardly likely to begin to be manifest during the next few decades.

It is also safe to count on a considerable increase in the number of work animals either made necessary by expansion of crop area or greater intensity of cultivation on old lands. Judging from the experience of the United Kingdom an increase of at least 40 per cent in number of horses per thousand acres would be necessary in order to effect an increase of 47 per cent in yield per acre.[46]

[46] Even as compared with English requirements the assumption of an increase of 40 per cent in number of horses and mules appears a conservative one and makes considerable allowance for the substitution of tractors and other forms of mechanical power. It is difficult to allow for this factor. Some would make greater allowance for the future displacement of horses by these means. Apparently, thus far, there has been some progress in this regard. During the past decade the number of horses and mules per thousand acres of cultivated land decreased from 75 to 69. On the other hand, such studies as have been made indicate that the tractor does not displace more than 15 to 20 per cent of the horses on the average farm outside of the wheat regions. Moreover, there are probably large areas of the country where topographic conditions do not favor the introduction of tractors.

Economies in Acreage Requirements That Might be Effected by Certain Changes in Our National Standards of Consumption.

In the following estimates of the economy in acreage resulting from changes in standards of consumption, the present yields per acre have been assumed, so as not to confuse for the moment the effects of changes in productivity. Later, the possible economies in land area resulting from both causes may be considered in conjunction.

Crop and Pasture Land.

Since livestock require so large a part of our total farm acreage, it is natural to look to this phase of our consumption as affording the principal opportunity for economy—a fact that has been demonstrated by the experience of more densely populated countries.

The food scarcities of the war period resulted in very careful estimates of per-capita consumption for two countries, the United Kingdom and Germany, which give us a basis of consideration of the problem.

In Table 6 is given the per capita consumption for the United Kingdom and the United States of food products from livestock.[50]

TABLE 6.—*Per capita consumption of food products from livestock, the United Kingdom and the United States.*[1]

Products.	United Kingdom (pounds per capita).	United States (pounds per capita).	Per cent the British is of the American.
Beef and veal	64.0	68.36	93.6
Mutton and lamb	29.1	5.34	544.9
Pork, bacon, ham and lard	41.6	83.80	49.6
Poultry (and game)	2.7	[2] 20.20	14.4
Eggs	12.5	28.30	44.2
Milk (including cream and condensed milk)	246.4	418.80	58.8
Butter	15.6	15.23	102.4
Cheese	7.2	3.45	208.7
All dairy products in terms of milk for human consumption	646.0	773.13	83.6
Fish	41.4	17.00	243.5

[1] The figures for beef and veal, mutton and lamb, and pork do not correspond exactly to the statistics gathered by the Bureau of Crop Estimates in an attempt to obtain from crop correspondents the consumption of these products by sections. See Yearbook 1920, p. 828.

[2] Game is not included in the United States figure.

From the standpoint of nutrition, of course, it is necessary to consider the entire diet of a people—vegetable products and fruits, as well as meats. Taking into consideration all its elements, the committee above referred to estimated the British food supply, as represented by the average for 1909–13, to be somewhat above the minimum necessary to maintain the population in an efficient working condition. The actual supply consumed was estimated to be in

[50] The data for United Kingdom are derived from the report of "A Committee of the Royal Society at the Request of the President of the Board of Trade." London, H. M. Stationery Office, 1917, and comprise the average annual consumption for the years 1909–13. The American figures comprise the average annual consumption for the years 1918–23.

excess of requirements, by 11 to 14 per cent of proteins, 25 to 30 per cent of fats, and 10 to 14 per cent of carbohydrates.

If these conclusions are correct, we should be amply nourished as a nation though not necessarily wisely nourished, if we should adopt the British standard. The most important difference, so far as livestock products are concerned consists in the much greater consumption per capita of mutton in the United Kingdom, offset in the United States by a relatively greater consumption per capita of pork and pork products, poultry, eggs, and dairy products.

For the present investigation the important question is: Would there be an economy in the requirements of crop and pasture land if we employed the British standard of consumption of livestock and livestock products? A careful estimate indicates that, in providing for a population of 150,000,000 people, we should save about 43,000,000 acres of crop land, compared with the requirements under our present standard of consumption.[51]

On the other hand, assuming that the area of semiarid pasture and woodland pasture are constant, as in previous estimates, we should find it necessary to provide about 37,000,000 acres more of humid pasture, other than woodland, than would be required for 150,000,000 people under the American standard.[52]

The apparent anomaly that under the British standard we should economize in crop area but require an increase in pasture area is due to the fact that the largest economies under the British standard are in hogs and poultry, which require relatively large amounts of crop land but relatively small amounts of pasture; while, on the other hand, the British requirement for sheep is 445 per cent above our own, and sheep require comparatively little crop area but large areas of pasture.

As a matter of fact, the British standard is not a normal one for a self-sufficing nation of dense population. It is made possible by the policy of depending largely on foreign sources of supply. A much more normal example of the adjustments in consumption of

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[51] The estimate was made as follows: The acreage required for each class of livestock other than horses for a population of 150,000,000 was calculated, and this was multiplied by the percentage the British per-capita consumption for this class of livestock is of the American per-capita consumption. The sum of the average requirements for the various classes of livestock was then added to the acreage required for other domestic uses under a population of 150,000,000. This total was divided by a factor representing the ratio of acreage required for domestic consumption exclusive of the maintenance of horses to the acreage required for horses. The quotient added to the other acreage previously estimated gives the requirement under the British standard. The American consumption of poultry is relatively very much higher as compared with that of the United Kingdom than it is for eggs. This is partly due to the fact that the United Kingdom imports a large part of its supply of eggs, while the greater part of the American supply is produced at home, with the consequence that the surplus poultry incidental to egg production is consumed at home. It was therefore considered best to take the relative consumption of eggs rather than the relative consumption of poultry as a basis of obtaining the economy in acreage. To determine the proportionate consumption of all dairy products the per-capita consumption of butter and of cheese was reduced to whole milk.

[52] The estimate was made as follows: The number of animal units for each class of livestock required for 150,000,000 people under the American standard of consumption was calculated. This was multiplied by the percentage the British standard of consumption for that particular class of livestock is of the American. The necessary number of horse units was determined by multiplying the horse units that would be required under the American standard of consumption by the ratio of crop acreage required for horses under the British standard to the crop acreage required for the maintenance of horses under the American standard previously estimated. From the total number of animal units that would be required under the British standard thus determined was subtracted the number of animal units now maintained by semiarid pasture and woodland. The ratios of the remainder to the number of animal units now maintained by humid grassland pasture was determined and this ratio multiplied by the acreage of humid grassland pasture now employed for domestic consumption, thus giving the area required under the British standard.

livestock and livestock products is afforded by Germany, for which country fortunately we have carefully prepared statistics.[53]

The pre-war food consumption of the German Empire (1912–13) comprised a much smaller use of meat per capita than that of the United Kingdom, but higher than that of France and other continental countries. Nevertheless, the German people were adequately nourished. It is estimated that the caloric value consumed each day per "average man"[54] was about 15 per cent in excess of the requirement as estimated by the Inter-allied Scientific Food Commission. Allowing for the importation of food, concentrates, and fertilizers, about 85 per cent of the food supply was domestic production and 15 per cent imported.[55]

The contrasts in the food consumption of Germany and of the United States in terms of percentage of total energy units (calories) derived from different kinds of food are shown in Figure 51. Table 7 shows the per-capita consumption of different kinds of food in the two countries measured in pounds, and the percentage of excess and deficiency of the American as compared with the German standard.

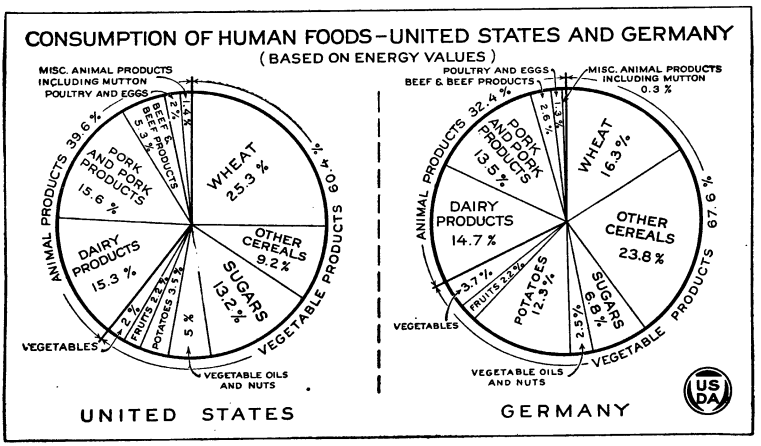

FIG. 51.—The German diet in the years just preceding the World War was ample in nourishment, but represented certain economies made necessary partly by scarcity of land and partly by a lower per capita income as compared with the United States. The combined consumption of cereals and potatoes for Germany comprised a much larger percentage of the total than in United States, although our consumption of wheat was a larger percentage of the total than in Germany. The percentages of energy units obtained from pork and dairy products are not greatly different for the two countries, but beef and sugar have a considerably larger place in the American than in the German diet.

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[53] "Report on Food Conditions in Germany," by Ernest H. Starling, with Memoranda on Agricultural Conditions in Germany, by A. P. McDougall, and on Agricultural Statistics, by G. W. Guillebaud (London, H. M. Stationery Office, 1919). The statistics on food consumption used herein are based on official statistics.

[54] By "average man" is meant a figure in which the women and children, for whom the food requirement is less than for men, are converted into equivalent man units. For the German Empire this was done by multiplying the total population by 80 per cent. After the war, however, as a result of the loss of man power, it was found that the equivalent was 84 per cent (in 1919).

[55] The undoubted undernourishment which resulted from the war is attributed in the above-mentioned report largely to the disorganization in production and distribution.

TABLE 7.—*Comparative per capita consumption of foodstuffs in Germany and the United States.*

ANIMAL PRODUCTS.

Kind.	Germany.[1]	United States.[2]	Per cent German figure is of American figure.
	Pounds.	*Pounds.*	
Beef and veal	39.40	68.36	57.6
Pork and pork products (including lard)	75.45	83.80	90.0
Mutton and lamb	2.00	5.34	37.5
Poultry	4.82	20.20	23.9
Eggs	15.99	28.30	56.5
Milk	283.30	418.80	67.6
All dairy products in terms of milk	711.34	773.13	92.0
Butter	15.44	15.23	101.4
Cheese	10.38	3.45	300.9
Fish	19.56	17.00	115.1

VEGETABLE PRODUCTS.

	Pounds.	*Pounds.*[3]	
Wheat flour	129.92	204.70	63.5
Rye flour	157.82	4.30	3,670.2
Corn meal or flour		58.40	
Rice	7.20	5.40	133.3
Other cereals (oatmeal, barley, buckwheat, etc.)	22.06	6.30	350.2
Total all cereals	317.00	279.10	113.6
Potatoes	407.27	150.10	271.3
Sugars	44.57	95.70	46.6

[1] Derived with minor modifications and adjustments for purposes of comparison from "Report on Food Conditions in Germany" by Ernest H. Starling and others.

[2] Animal products consumed in the United States—Beef and veal, pork and pork products, including lard, mutton and lamb are based on average consumption, 1918 to 1922, inclusive; statistics furnished by John Roberts, United States Department of Agriculture. Statistics on average consumption of dairy products in the United States, 1918 to 1922, inclusive, furnished by T. R. Pirtle, United States Department of Agriculture.

[3] From "The Nation's Food," by Raymond Pearl. Average consumption, 1911–18, inclusive, calculated from tables in Chapter XI.

On the basis of these comparative figures it is estimated that under the German standard of consumption of animal products there would be an economy of about 64,000,000 acres in the amount of crop land that would be required under the present American standard of consumption of animal products. However, the economy in crop land under the German standard of livestock consumption is offset somewhat by the relatively larger requirements of crops employed directly for human consumption. For the crops shown in Table 7 it is estimated that there would be needed for a population of 150,000,000 people about 27,000,000 acres more under the German standard of consumption of vegetable products than under the American standard. Whereas the Germans have a smaller per capita consumption of wheat and sugar and eat practically no maize, this is more than offset by their much larger consumption of potatoes and the other cereals, especially rye.[56] In short, the net saving in crop

[56] In making this estimate allowances were made for seed requirements and for the proportion of the area of the several crops employed in feeding livestock. The economy in sugar consumption is applied only to the acreage of cane and sugar beets in this country, not to the acreage required for the proportion of those crops imported. In calculating the respective acreage requirements for rye the percentage in Table 7 was not employed, because of the tendency to exaggerate unduly possible errors in the small estimate of rye employed for human consumption in the United States. Consequently, it was found best to calculate the rye requirement direct from the statistics of German production and consumption.

acreage under the German standard is about 37,000,000 acres. The greatest saving, however, would be in the case of pasture. It is estimated that under the German standard the requirement of humid pasture other than woodland would be 121,000,000 acres less than under the American standard, owing to the large economies in the use of the pasture-consuming animals—sheep and beef cattle.

Consumption of Forest Products.

As shown by Figure 52, the possibilities of reducing our per-capita consumption of forest products are very great. As between the 234 cubic feet per capita of standing timber annually used or wasted in the United States [57] and the 27 cubic feet of France and Germany, or

ANNUAL PER CAPITA CONSUMPTION OF WOOD, UNITED STATES COMPARED WITH VARIOUS COUNTRIES AND REGIONS.

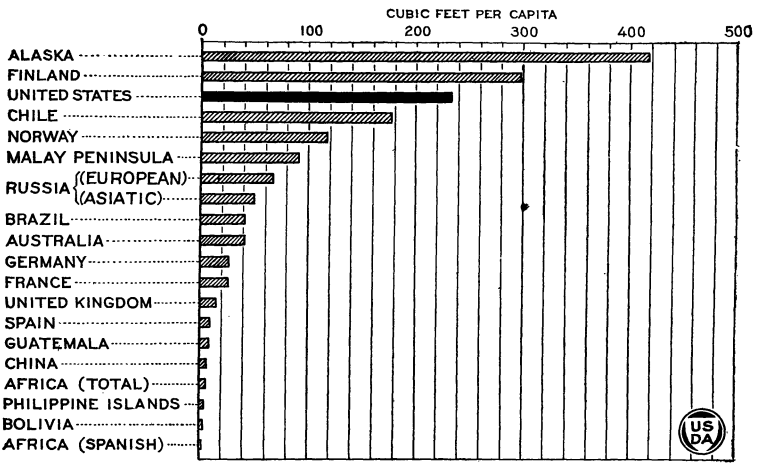

FIG. 52.—The per capita consumption of timber is closely related to the abundance or scarcity of it in the various countries. It is especially large in countries which are still cutting from a stored-up supply, or where so large a proportion of the total area is mountainous that the population is small in proportion to the total land surface, as well as to the total area of forest, as in Norway. The per capita consumption tends to be small in countries of dense population, especially where it is necessary to rely on annual growth, such as Germany and France. It is also small in countries of sparse population but slight industrial development, such as Guatemala, Bolivia, and Spain. In the last two countries another factor is the considerable area of semiarid land, which tends to reduce the proportion of forest to the total area. The figure for the United States includes wastage from fire, while this loss is not included in the consumption figures of the other countries, the loss from this cause being very small for most of them. Because a large part of the supply is imported, the figure for the United Kingdom represents mainly sawed and hewed timber.

the 15 cubic feet of the United Kingdom, there is obviously a great gap which may be considered not absolutely essential to the maintenance of civilization.

However, the mere fact that some of the European nations find it physically possible to get along with from 15 to 27 cubic feet per capita, while we employ 212 no more means that a reduction to the European level is economically desirable than the fact that a certain man of limited income manages to exist on $1,000 makes it desirable

[57] On the basis of the population in 1920.

for a man with an income of $10,000 to reduce his expenditure to the level of the less fortunate individual.

If we were willing to reduce our living standards drastically and to curtail our industrial consumption of wood to the level of Germany or France, the present rate of growth in our growing forests would provide for a population of about 235,000,000 people. If, on the other hand, we cared to use the intensive methods of forestry of Germany and employed only land too rough or too poor for use in crops (see p. 474), we could supply timber for about 485,000,000 people, according to the French or German standards of consumption, or more than we could probably supply with food and clothing under a reasonable standard of comfort. If our entire present forest area were in growing timber, and assuming no change in rate of growth, we could maintain for a population of 150,000,000 a per capita consumption of 76 cubic feet, which is over one-third our present per capita consumption (fig. 53). This is merely another

PERCENTAGES OF PRESENT PER CAPITA CONSUMPTION OF STANDING TIMBER THAT WOULD BE AVAILABLE FOR 150,000,000 PEOPLE BY UTILIZING OUR PRESENT AREA OF FOREST LAND AT VARIOUS RATES OF GROWTH.

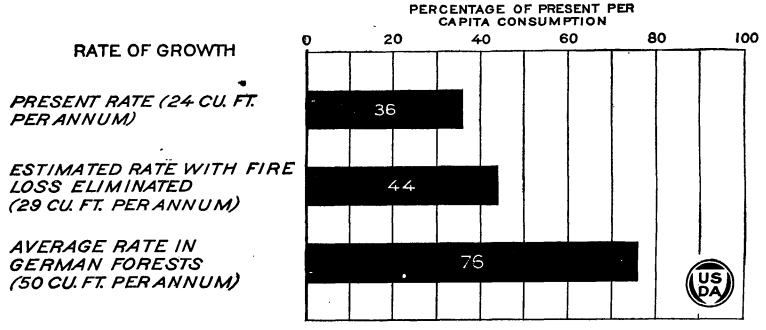

FIG. 53.—On our present forest area, including the 81,000,000 acres denuded and not restocking, it would be possible to provide for 150,000,000 people at present rates of growth on the growing area only a little more than a third of our present per capita consumption. The elimination of fire would increase the supply by about one-fifth. If the average rate of growth for the German forest area could be attained, our present area could supply annually three-fourths of our present per capita consumption. However, this would involve very intensive systems of forestry on an area about fourteen times that of the forests of Germany.

way of saying that so drastic a reduction in per capita consumption is likely to be unnecessary.

Moreover, the reduction in our per capita consumption of forest products to that prevailing in Germany and France would involve costly substitutions, as well as serious deprivations in the standard of living of our population. The people of those countries have been schooled for centuries in the scanty use of wood, whereas in the United States our whole social and economic structure has been based on the use of wood in abundance. Indeed, leaving out of account the present unnecessary wastes, it would appear undesirable to make any reduction in our per capita consumption of timber that is not required by the lack of available land.

It is true, our large per capita consumption can be somewhat reduced with less real than apparent hardship, by eliminating some of the unnecessary wastes and the less important uses. Of our total annual cut of 22½ billion cubic feet of standing timber, only about one-third is sawed lumber, including dimension material and sawed ties (fig. 54). Most of the remainder consists of such items as fuel wood, hewed railroad ties, pulpwood, mine timbers, and similar products. Wood used for fuel alone amounts to nearly two-fifths of our timber cut.

Moreover, in the United States large amounts of such products as fuel wood, mine timbers, pulpwood, and fence posts come from

AVERAGE ANNUAL REMOVAL OF STANDING TIMBER FROM THE FORESTS OF THE UNITED STATES ASSIGNED TO VARIOUS TYPES OF USE OR CAUSES OF DESTRUCTION.

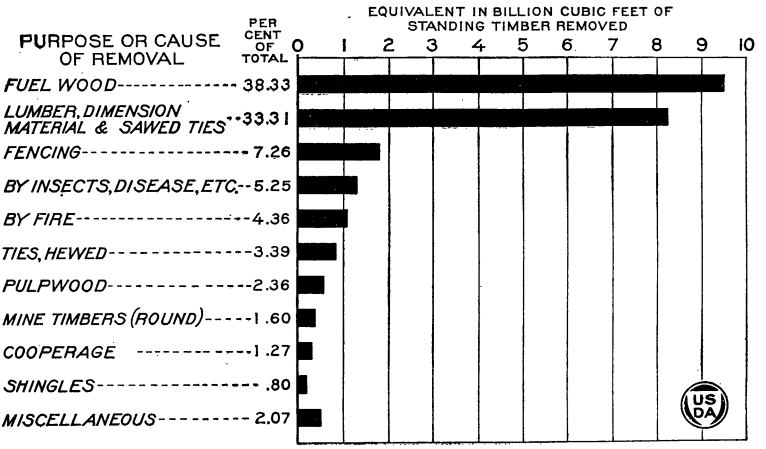

FIG. 54.—Of the total timber annually removed from the forests of the United States a little over 4 per cent is destroyed by fire and a little over 5 per cent by insects and disease. Lumber, dimension material, and sawed ties comprise about one-third of the total, but the timber of saw-timber size removed for various purposes amounts to more than half of the timber annually removed. About two-fifths of the total is employed for fuel. Pulp wood, though economically of great importance, represents only a little over 2 per cent of the timber annually removed. As indicated in Figure 55, nearly half of the total timber removed represents waste, but only a small part of this waste could be prevented without considerable increase in cost of utilization.

small trees that are potential saw timber, and often indeed from trees of saw-log size. Yet, much of these materials could come from the immense quantities of wood now wasted in the form of tops, limbs, stumps, and small or crooked logs, and of small trees that, with benefit to the remaining forest, could be taken out as thinnings. Thus, Sweden has built up a large paper industry, which derives its raw material almost solely from classes of wood that we now waste in woods and factory. The salvaging of this waste would release immense quantities of young growth for ultimate use as saw timber. The annual loss to standing timber from fire, windfall, insects, and disease is estimated at 7¼ billion board feet, most of which could be avoided by proper protective measures.

Equally conspicuous are the easily possible savings in the most valuable part of our timber supply, the saw-log material (fig. 55). Even a moderate reduction of the waste now occurring in the manufacture and use of saw timber and from fire and decay of lumber in use would add 7 billion board feet a year to our lumber supply. This is almost a fifth of our present lumber cut and is equivalent to the present growth of saw timber on 170,000,000 acres of forest land.

If in the near future we should adopt a crude system of forestry consisting chiefly of protection against fire and the provision of seed trees where needed, we could expect by 1950, on the area probably available for growing timber, a total annual growth of about 10 billion cubic feet, or about 4 billion more than the present annual volume of growth. This supposes that some of our forest area will still be in virgin timber, and consequently will not be available for growing timber. This growth, if relied on as our total supply,

AVERAGE ANNUAL REMOVAL OF STANDING TIMBER IN THE UNITED STATES THROUGH WASTE, DESTRUCTION, OR USE.

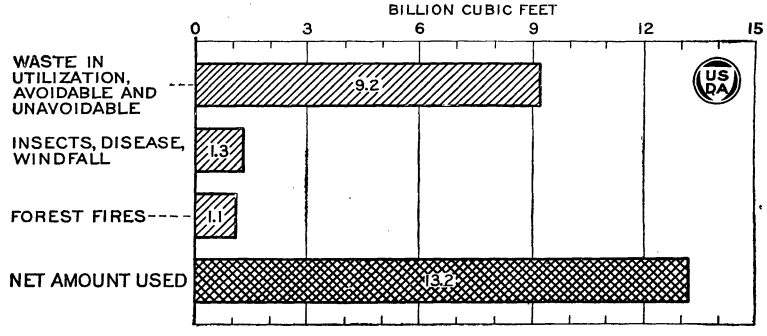

FIG. 55.—It is estimated that of the 25,000,000,000 cubic feet of standing timber annually removed from the forests of the continental United States nearly one-half represents waste. About one-tenth of the total removal is due to fire or insects and disease. The greatest volume of waste is in manufacture and use, comprising more than a third of the timber annually removed. However, most of this waste is not now avoidable without increasing considerably the cost of utilization.

would give a per capita consumption of about 67 cubic feet for a population of 150,000,000. This figure, however, will be increased by reason of the reserve supply of virgin timber, which may last well into the latter half of the present century, though of course it will become increasingly scarcer and more inaccessible and consequently higher priced. It may also be increased by imports, though at present imports and exports are about balanced. Large imports are probably out of the question, because of high transportation charges and growing competition for the timber of foreign countries, particularly conifers. It may also be somewhat further increased by the use of more intensive forestry in public forests, and in the more favorably situated private forests. But that by 1950 our per capita consumption will be markedly below what it now is seems inevitable. The trend of prices in itself creates a strong economic pressure toward lower per capita consumption. Compared with 1840 the average

price of lumber is now more than five times what it was then, whereas the average prices of all commodities are less than one and one-half times as great. One of the large elements in the high prices of lumber is the cost of freight, which has increased steadily with the increasing length of haul.

The fact is our per capita consumption of lumber had been declining for some time prior to 1920. In was higher in 1870 than in 1920. It rose steadily until 1906; from 1906 to 1920 it declined steadily at an average yearly rate of 2.8 per cent. Since 1920 consumption has been increasing, partly no doubt because of the resumption of construction activity suspended during the World War.

The future trend of consumption is impossible to predict, though there are certain tendencies that will permit us to make a fair estimate. The chief limiting factors will be, as in food production, the land available and the amount of labor and capital that will be devoted to timber growing. As we shall show, it is unlikely that our present forest area of 483,000,000 acres will need to be decreased in the next half century. If the present area were all in growing timber and were managed as intensively as the better managed forests of Germany, it could be made to produce about 28 billion cubic feet a year, which would give for a population of 150,000,000 a per capita supply of 180 cubic feet, and for 200,000,000, 135 cubic feet.

The production of 28 billion cubic feet a year within the next four or five decades is, however, entirely impossible. Even granted the land, the labor, and the capital necessary, it would require a long time to get all our forested land, including the 138,000,000 acres of virgin forest that still remain to be cut before growth starts, into productive condition, for most of our forests are badly understocked.

Probable Changes in Land Requirements During the Next Few Decades.

The preceding discussion has indicated the acreage of crops, pasture, and forest land that would probably be required to provide for domestic consumption under each of three extreme assumptions: (1) No reduction in per capita consumption and no increase in rate of yield per acre; (2) increasing yield of crop land to the average now prevailing in four countries of western Europe, and of pasture and forest to the averages characteristic of Germany in the period before the World War; and (3) decreasing per capita consumption to the standard prevailing in Germany before the recent war. The areas of land required for 150,000,000 people under each of the three assumptions may be summarized as follows:

TABLE 8.—*Land requirements for a population of 150,000,000.*[1]

Type of land use.	Assuming no changes in per capita consumption, or in the average yield per acre of crop land, carrying capacity per acre of pasture land, and annual growth per acre of forest land.		Assuming no changes in per capita consumption, but an increase to European standards in yield per acre of crop land, carrying capacity per acre of pasture land, and annual growth per acre of forest land.[2]		Assuming no changes in yield per acre of crops, carrying capacity of pasture, and growth of forests per acre; but a reduction in per capita consumption of food and forest products to the standard prevailing in Germany prior to the World War.	
	Total (thousands of acres).	Acres per capita.	Total (thousands of acres).	Acres per capita.	Total (thousands of acres).	Acres per capita.
Crop land	431,000	2.87	270,000	1.80	394,000	2.63
Humid grass land pasture	336,000	2.24	121,000	0.81	215,000	1.43
Semiarid pasture (constant)	587,000	3.91	587,000	3.91	587,000	3.91
Woodland pasture (constant)	237,000	1.58	237,000	1.58	237,000	1.58
Forest [3]	1,465,000	9.77	636,000	4.24	169,000	1.13
Provisional total	3,056,000		1,851,000		1,602,000	
Less duplication of forest and woodland pasture	237,000		237,000		169,000	
Net total	2,819,000	18.79	1,614,000	10.76	1,433,000	9.55

[1] With no allowance for exports and assuming the same proportion of our national consumption of farm products obtained from imports as for the present population.

[2] For maximum increase in crop yields, the basis of determination was the average yields, for four European countries; in humid pasture the carrying capacity of pastures in Germany; for semiarid pasture, the results of certain experiments under public management in this country; and for forests the average annual growth in the forests of Germany (see pp. 463–475).

[3] Area required for growing the timber consumed instead of cutting from a stored supply.

Each of the three columns in Table 8 is based on extreme assumptions. Nevertheless, they are exceedingly useful in defining some of the limits of the problem of land utilization. The first column emphasizes the fact that without important changes in methods of production, standards of consumption, or both, we could not provide for a population of 150,000,000 people. The second and third columns rest on the assumption that one type of adjustment will be exclusively employed—that is, either increase in production per acre or modification in standards of consumption. However, by the time a population of 150,000,000 people is reached, it is exceedingly unlikely that we shall increase the productivity of our crop land by 47 per cent, the carrying capacity of our humid grassland pasture by 122 per cent, and of arid pasture by 50 per cent, and more than double the average annual growth of our growing forests. On the other hand, it is scarcely probable that we shall modify our consumption of food products to approximate the economies of the German standard or reduce our annual per capita consumption of timber to only one-eighth of the present requirement.

Obviously, both adjustments in some measure will be made. These extremes are useful in showing the maximum economies that might be accomplished by each method, and thus indicate the limits within which an estimate of probable requirements may be made. The essential problem is to determine to what extent we shall employ each of the two methods of economy. It is, of course, obvious that in at-

tempting to answer this question we enter a field of prediction where the elements of uncertainty are numerous. However, one fact is clear, we shall be nearer the truth by assuming any combination of the two changes which are between the two limits of no change in either respect, on the one hand, or of a full change in both respects, on the other hand.

As to the relative importance of the two methods of economy, in the case of crop and pasture land, there are certain considerations which apparently indicate roughly the probable course the nation is likely to pursue. In the first place, the element of sacrifice involved in the German standard of consumption would be very much less than that involved in increasing production to the extremes assumed above. At most, the former involves the reduction of our per-capita consumption of mutton from 5.3 pounds to 2 pounds,[58] of beef and veal from 68 pounds to 39 pounds, of pork and pork products from 84 pounds to 75 pounds, of eggs from 28 pounds to 16 pounds, and of dairy products (in terms of milk) from 773 pounds to 711. There would also be certain changes in crop consumption, such as a reduction in consumption of sugar and increase in the consumption of cereals and potatoes. This is the extreme. It is not probable that we shall need to go this far in modification of habits of consumption, for it is reasonable to expect some increase in the production per acre of crops and of livestock products. However, it appears both desirable and probable that we shall go a considerable distance in the direction of this extreme economy of consumption, a probability that is emphasized by considering the extent of the task of effecting by increased efficiency of production most of the requisite economy.

Probable Changes in Production in Next Four Decades.

To increase our average crop production per acre 47 per cent may sound easy, but when we remember that this is an average increase to be attained for all of the crop land of the United States, the magnitude of the task that must be accomplished in perhaps little more than three decades if this method of economy alone were employed appears stupendous. Moreover, it should be noted that our record thus far indicates a very slow rate of progress in productive efficiency, so far as concerns increased yield per acre,[59] whereas, on the other hand, the increasing scarcity of grazing land has already resulted in a considerable decrease in number of livestock per capita.

Furthermore, the experience of Europe has shown that the high level of yield per acre achieved in those countries has been accomplished at exceedingly heavy cost as compared with this country. It involves a quantity of human labor per acre which is several times that of the United States, together with almost an equal quantity of animal power, and probably a considerably greater expenditure for fertilizer (see p. 475). While allowance must be made for differences in agricultural organization in this country and in Europe, all things point toward the probability that a marked increase in yield per acre is likely to involve an increase in costs per acre in considerably greater proportion.

[58] With either a corresponding economy in wool or increased importation.
[59] See p. 463.

In regard to crop land another important consideration is the fact that there remains a large area of humid land of fair productivity which can be added to the existing crop area by clearing operations no more costly than have been employed in that part of our agricultural expansion which preceded the expansion into the prairies and the Great Plains, as well as considerable areas of drainable and irrigable land of high fertility, not to mention the possibilities of expanding the crop area in the dry-farming regions. Much of the land referred to is now put to very low use. The value of the uses displaced by crops for the land needed during the next few decades, together with necessary capital charges for clearing, draining, or irrigating, are likely to be proportionately much lower than the increase in costs that would be involved in attaining by increased intensity of cultivation a degree of productivity comparable with that of Europe. It seems reasonable to believe that in the next three or four decades we may increase the yield of crop land by the use of some additional fertilizer, but probably without greatly increasing otherwise the intensity of field processes. In view of the above considerations, it would not appear wise to count on an increase in the average productivity of crop land by more than, say, 10 per cent in the next three or four decades, though unforeseen circumstances might result in a greater increase.

It has been noted that the possibilities of increase in carrying capacity of humid pasture other than woodland are very great, if we may judge by the example of Germany. The economy in the use of pasture area may take several forms: The substitution of forage and root crops for pasture is one of these. This tendency may be illustrated by the fact that in Germany the area of pasture other than woodland is a little over 60 per cent of the crop area, while in this country the area of humid pasture other than woodland, together with its equivalent in semiarid pasture, is about 118 per cent of the area of land in crops (fig. 56). It will be noted that the substitution of forage crops for pasture involves a larger labor requirement per thousand acres of both crops and pasture, although it does not necessarily imply an increase in the intensity of cultivation of crop land or an increase in its yield per acre. Again, increase of carrying capacity of pasture may be achieved by laying down permanent pasture instead of depending on spontaneous growth. This also involves a larger labor contribution in the national farm economy. The increased productivity of pasture may be achieved by better selection of pasture plants; better preparation of the land and more careful methods of laying down pasture; better adjustment of the time and intensity of use; and, in the sections where the pasture economy has become intensive, by the use of fertilizer on permanent pastures, as well as on rotation pastures. Finally, pasture economy may be furthered by more efficient methods of livestock husbandry, such as adopting high-grade livestock and employing such practices as will attain a maximum number of offspring, minimum losses, and maximum growth. These measures are especially important on the western ranges.

While the full employment of all these various methods may ultimately much more than double the carrying capacity of our humid pasture other than woodland and increase it by possibly 50

per cent on our semiarid range, it may be doubted if in the next three or four decades we shall succeed in raising the average level of productivity by more than 20 or 25 per cent throughout our enormous area of semiarid and humid pasture exclusive of woodland. Throughout large areas it is improbable that any considerable increase in productiveness will occur, for, the policy of relying on spontaneous pasture growths is likely to prevail. The use of fertilizer on permanent pastures is not likely to become general within that period, nor is it probable that the available supplies of fertilizer would make possible its general employment over so large an area. It is unlikely that the carrying capacity of woodland pasture will increase by any considerable amount.

ACRES OF HUMID PASTURE PER HUNDRED ACRES OF CROPS, UNITED STATES (EXCLUDING EXPORTS), COMPARED WITH FRANCE AND GERMANY.

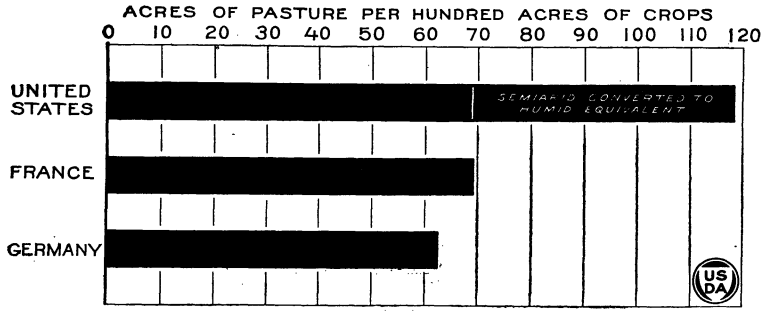

FIG. 56.—As the density of population in a country increases there is a tendency to rely more largely on crops rather than on pasture for the maintenance of livestock. The area of crops and pastures used for the United States excludes acreage employed in producing for export. If allowance were made for the crops imported and fed to livestock, the ratios of pasture land to crop land for Germany and France would be still smaller. The area of semiarid pasture in the United States has been converted to humid pasture on the basis of relative carrying capacity. For all three countries woodland is excluded, although used to some extent for pasture. It is probable that the proportion of total livestock units maintained by woodland pasture is slightly larger for the United States than for Germany and France.

Any forecast of the probable rate of increase in the average growth per acre of growing forest during the next few decades is complicated by numerous difficulties, particularly by the ownership of forest land. About 21 per cent of our timberland (exclusive of scrub forest) is in public ownership, and of this about 93 per cent is being handled to assure continuous growth of timber. About 79 per cent of our forests (and potentially among the most productive) is privately owned. Of this amount, 40 per cent is in farm wood lots and 60 per cent in other forms of ownership, chiefly large commercial holdings.

It may be safely predicted that all public forests will be more and more intensively managed, and will be largely added to from lands that would be much less productive if left in private ownership. Public ownership will thus add materially to the average annual growth per acre. Another factor that will probably increase our net total growth is the conversion of virgin forests, where growth is largely offset by decay, into young, growing forests. At present, however, a large proportion of the national forests consists of virgin

timber, which in many cases will not be in great demand until more accessible supplies are exhausted. Consequently, cutting off the old timber and getting a new crop started will necessarily be a gradual process.

The chief problem, then, is with respect to the private timberlands. At what rate may we expect these lands to be made more productive? Productive methods with farm woodlands, occupying some 150,000,000 acres, are hampered by the general lack of knowledge by farmers of the means to be employed. On the whole, for this important portion of our area of forest land we may perhaps expect a decrease in acreage and only a slow increase in rate of growth per acre.

For large commercial holdings the outlook is somewhat different. The increasing pressure of economic forces making for better forest management and higher yields is unmistakable. In several parts of the country, notably the Northeast, high prices of lumber and long freight hauls are making it profitable for the private land owner to grow timber as a crop. There is a well-defined movement to prevent in the public interest the denudation of private forests. Still more apparent is the trend toward public and private cooperation, on an adequate scale, for the control of forest fires. Such control is the first and most indispensable step toward making our forest land productive. Efforts are being made here and there by private industries to assure a continuous supply of timber by the careful cutting of their mature timber and by buying up lands stocked with young growth. However, the tendency toward private forest management is only in a formative stage. Only 43 per cent of our private timberlands have even partial protection from fire; and an almost negligible fraction get the benefit of more intensive measures for timber production.

Compared with the production of other crops, there is a far greater chance for increasing forest yields at a comparatively small expenditure. Under the crudest measures, chiefly protection against fire and leaving seed trees in some of the forest types, our annual growth on all forest lands, including virgin forests yet to be cut over, could be increased by 1950 from the present 6 billion cubic feet to 10 billion cubic feet. If these same crude measures should be permanently practiced, we could, on our present forest area, ultimately reach an annual growth of something like 14 billion cubic feet, about 56 per cent of our present forest drain.

The various measures mentioned probably will gradually ameliorate the outlook for our timber supply. At what rate this amelioration will occur depends so largely on psychological factors, public policy, and other unpredictable conditions as to make a forecast impracticable. It appears unlikely that within that period there can be so marked an increase in the average rate of growth per acre in our growing forests and in our gross yield as to offset the decrease in consumption forced by forest destruction.

Probable Changes in Consumption in Next Few Decades.

Some of the probable changes in consumption of crop products during the next 30 or 40 years should also be considered. In the first place, it is quite unlikely that we shall curtail our consumption of

sugar to the German standard. Even if we do not increase the proportion of the supply imported, it would not require a very large addition to our crop acreage to maintain the present per-capita consumption; in other words, the acreage required is comparatively small in proportion to the consumption utility involved. Again, it is doubtful if the cereal consumption habits of the American people will be greatly modified. The pressure of population in the next four decades will not be great enough to compel so prosperous a nation to substitute potatoes largely for bread or to shift from a wheat bread to a rye bread diet, and but little economy in land would result. There may be some tendency to shift to corn bread, because of its relatively greater cheapness. It is likely that some little increase may occur in the per capita consumption of potatoes and cereals to offset some of the probable reduction in the consumption of certain livestock products.

The principal changes, therefore, are to be looked for in the consumption of livestock products. The per capita consumption of dairy products is not likely to decrease very much, if at all. We have noted that even in so densely populated a country as Germany the per capita consumption of milk and milk products is but little less than in the United States. The consumption of mutton is very small in the United States. The greater proportion of our sheep are raised principally on pasture. If we should raise the same proportion of our wool supply as at present, this would enable us to maintain approximately the present per capita consumption of mutton, since the imports and exports of mutton are negligible. If we may judge from the experience of Germany the per capita consumption of pork and pork products is likely to decrease but little. Because of their ability to thrive on various forage crops yielding a large feed product per acre, and because of their comparatively small adaptability to the ordinary types of pastures, the relative importance of hogs is likely to increase as it becomes necessary to employ forage crops more and more in order to economize pasture; and, if anything, this relative increase is likely to be at the expense of classes of livestock better adapted to a pasture economy, such as beef cattle or sheep. Even in Germany the per capita consumption of pork and pork products is only about 10 per cent less than in the United States. It is probable, then, that when our population reaches 150,000,000 our per capita consumption of pork and pork products will be at least 95 per cent of the present consumption.

The per capita consumption of eggs in Germany is only a little more than half as great as in the United States. However, even before the World War, Germany was a relatively poor country, as compared with the United States. It is not likely to be a scarcity of land that will compel a serious curtailment in consumption of eggs and poultry, for in proportion to food produced, poultry require relatively little land and much labor, as compared with cattle and sheep. Consequently, they are especially adapted to the economy of a dense population. If the consumption of poultry and eggs per capita should seriously decrease, it is more likely to be due to the increased pressure of other food costs on the family income than because of the demands made by poultry on the supply of land.

If we approximated the German standard, we should consume only about three-fifths as much beef as at present. A population of 150,000,000 would not be dense enough to compel a reduction to the German standard. Moreover, the people of British origin who have so largely moulded our national standards, have exhibited great tenacity in clinging to a high per capita consumption of beef. However, we have already reduced our per capita consumption of beef considerably in the last two decades, and the increasing scarcity of pasture is likely to reduce it still more. As a basis for estimating land requirements, we may not be far wrong in assuming a reduction of 20 per cent in the number of beef cattle per capita.

It seems wise to consider that the number of horses and mules per thousand acres of crop land will continue as at present. The probable increase in productivity of crop and pasture land assumed above is not likely to increase the requirement per thousand acres of crop land by more than enough to offset the continued substitution of tractors and motor vehicles.

As already noted, our stock of timber would last for several decades even at the present rate of per capita consumption. However, the increasing remoteness or undesirability of remaining supplies is likely to result in increasing values and, therefore, probably in a continuation of the tendency toward a decrease in per capita consumption. For the period following the next few decades our per capita consumption depends very largely on what measures we take by way of providing for reforestation, promoting growth of timber, and reducing waste. It has been shown that on our present forest area it would be possible by methods of production relatively not very costly to grow annually by, say, 1950 about 10 billion cubic feet. This would give for 150,000,000 people a per capita supply of about 66 cubic feet, or more than double the per capita consumption of Germany or France. However, this presumes the early adoption of a vigorous forest policy. Moreover, while some of our stock of virgin timber will undoubtedly still remain uncut in 1950, it is likely to be in the more remote locations.

We have now made certain assumptions that will enable us to estimate roughly the probable land requirements when our population has increased to 150,000,000 people. On the basis of the assumptions of probable modifications in per capita consumption and of increase in productiveness of crop land, and in the carrying capacity of pasture, we shall require for a population of 150,000,000, three or four decades hence, about 373,000,000 acres of crop land and about 222,000,000 acres of humid pasture other than woodland, the areas of semiarid pasture and of woodland being held constant as in previous estimates. This estimate makes no allowance for exports and assumes the continuance of the present per capita imports of agricultural products.[60]

[60] The requirement for crops was estimated as follows: The changes in crop acreage used in producing food for direct consumption were estimated by assuming that the per capita consumption of certain items for 150,000,000 people will be the following percentages of present consumption: 103 per cent for cereals, 110 per cent for potatoes, 90 per cent for sugar, 95 per cent for hogs, 80 per cent for beef cattle, and 80 per cent for poultry, the other classes of food remaining unchanged. The requirement for work stock was estimated as follows: The areas at present used in producing food crops for domestic consumption, employed in producing crops used in feeding livestock, and for producing

Although the requisite increase in crop acreage to provide for 150,000,000 people, as compared with the acreage now employed for domestic consumption, is only a little larger than the acreage in crops now employed in producing for export (including the acreage required for maintaining work stock used in export production), it is not likely that we shall divert all of the land now used in producing for export to production for domestic consumption. Our country is especially adapted to the production of certain kinds of crops needed by the rest of the world, particularly cotton. It is not improbable, therefore, that (including the acreage required for work stock) we shall continue for several decades to devote to export production at least half the acreage we now employ for that purpose. This would add about 30,000,000 acres to the requirement of crop land, making a total of 403,000,000 acres. This is about 38,000,000 acres more than the acreage of harvested crops [61] in 1919, and requires the addition of about 1,000,000 acres a year. The allowance of half the present export acreage would also make necessary an addition of about 11,000,000 acres of humid pasture other than woodland, making a total requirement of 233,000,000 acres of humid pasture, or about 2,000,000 acres more than the present area.

It therefore appears that, provided we can make the very moderate modification in standards of consumption and productive efficiency assumed as a basis of these estimates and devote to domestic production about half the area now employed in producing for export, our needs for expansion of the farming area to provide for 150,000,000 people would be satisfied by adding about 40,000,000 acres of crop land and improved pasture to the farming area.[62]

The very moderate requirements for crop land and pasture will leave a very large area available for forests. It will be recalled

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crops for export were added. The sum was subtracted from the total acreage in harvested crops (1919), leaving the area employed at present in producing nonfood crops for domestic consumption. This figure was increased by the ratio of 150,000,000 to the population of 1920, and the resulting figure added to the estimated acreages required for food crops, and for livestock other than work stock, the sum of the three items being the estimated acreage of crops required for 150,000,000 people under the assumed changes in consumption, not including the area used to produce feed for work stock. The ratio of this figure to the corresponding figure for the population of 1920 was determined, the result being the ratio of work stock required for 150,000,000 people under the assumed changes, as compared with the number now required. The acreage required at present for work stock employed in producing for domestic consumption was multiplied by this ratio, and the result added to the acreage required for domestic purposes other than feeding work stock, as previously estimated. The sum was divided by 1.1 in order to allow for the assumed increase of 10 per cent in the average yield per acre of crop land.

The requirement of humid pasture was estimated as follows: The numbers of animal units of the different classes of livestock other than work stock to supply 150,000,000 people, under the assumed changes in consumption, were calculated by employing the same factors as in the case of crop acreage above. The percentage increase of work stock was calculated on the basis of the ratio of crop acreage required under the assumed changes in consumption and production, as previously estimated, to the acreage of crops in 1919. The number of animal units on semiarid pasture in 1920 was multiplied by 1.2 to allow for an increase of 20 per cent in carrying capacity. The sum added to the number of animal units on woodland pasture was subtracted from the total number of animal units required, the remainder being the number to be maintained by humid pasture. The ratio of this to the number of animal units now on humid pasture was determined and the acreage of humid pasture now employed for domestic consumption was multiplied by this ratio.

[61] For statistical reasons the estimates have been made on the basis of harvested crops. Allowance would also have to be made for the small additional acreage for crop failure, estimated at about 15,000,000 acres in 1919. However, it is probable that the proportionate requirements for this purpose would not greatly change. In a given year there is also a certain acreage of crop land in rotation devoted to pasture.

[62] If we should fail to economize as much as the very moderate modifications in consumption and production assumed as the basis of these estimates imply, the requisite increases of crop and pasture land would fall somewhere between the above estimates and the increase of 96,000,000 acres of crop land and 116,000,000 acres of humid pasture that would be necessary if no economies in consumption and production are effected (p. 462), allowing in each case half the acreage at present employed for exports.

that after allowing for the present requirements for roads, cities, railways, farmsteads, etc., and for the land that is physically incapable of being employed for crops, pasture, or forests, there remains an area of 1,769,000,000 acres available for the three uses. Allowing about 10,000,000 acres of land for the expansion of the area required for cities, roads, etc., during the next few decades, there remains available, 1,759,000,000 acres. Subtracting from this the 587,000,000 acres of semiarid pasture, the 403,000,000 acres of estimated requirement for crop land, an allowance of about 40,000,000 acres of crop land for annual crop failure and crop land fallow, and the 233,000,000 acres estimated to be required for humid pasture, there remain 496,000,000 acres of surface not required for any other use than forests, or 13,000,000 acres more than are now included in the area of forest and of cut-over land not restocking. In other words, with the reasonable economies and changes in foreign trade assumed above, it will be possible to meet the needs of a population of 150,000,000 for crop land and pasture and still have left an area larger than the present forest area.[63]

This does not mean that the 496,000,000 acres of surface left would all be adapted to forests. Some of this land would have to be reclaimed by drainage at an expense so excessive that it probably may never be reclaimed, even when the maximum population of the nation is attained; and a little of it also is too dry for trees. Consequently, it seems probable that the land available for use as forests during the next forest cycle will not be larger than the present forest area of 483,000,000 acres, which includes, it will be recalled, about 81,000,000 acres of cut-over land not restocking.

The Direction of Expansion of the Area of Farm and Forest Land During the Next Few Decades.

For the additional 38,000,000 acres of crop land there are available a little over 600,000,000 acres of potential crop land from which to choose, after allowing for the area of land suitable only for forest or semiarid pasture. Allowing for an area of forest land equal to the present forest area, there remain nearly 400,000,000 acres of potential crop land. Practically all of this is either inferior in quality or requires drainage or irrigation.

It is obvious that to obtain 38,000,000 acres from this great area should involve careful selection. Moreover, each of the several classes of potential crop land is likely to contribute toward the required amount. It will be recalled that the forested regions of the eastern half of the country are estimated to contain 220,000,000 acres of land capable of use for crops without drainage (see figs. 9 and 11), besides 151,000,000 acres of land so rough or so sandy that it may be considered suitable only for forests. Of the former area, 32,000,000 acres are classed as heavy soil. This is more than the 22,000,000 acres required for the expansion of crops during the next few decades; but a good deal of this land, while not absolutely too rough for use in

[63] On account of new materials made available, these estimates are somewhat different from those given in testimony by L. C. Gray before the Senate Committee on Reforestation (S. Res. 398) and also quoted in the article "Timber: Mine or Crop," Yearbook, 1922. While the estimated areas are not identical, the essential conclusions are the same.

crops, is quite rolling, and some is infertile. However, it would seem possible by careful selection to obtain a large proportion of the required 38,000,000 acres either from the heavy land of the cut-over region or from the best of the 162,000,000 acres of medium-textured soils or from semiarid land. In view of these possibilities it would seem hardly necessary to reclaim a large area by irrigation or drainage for the expansion of agriculture during the next few decades, and certainly there would be no justification in undertaking such reclamation except in the case of projects where the economy of reclamation could be demonstrated unequivocally.

Maximum Population That Could Be Maintained by Our Resources of Crop, Pasture, and Forest Land.

The statistics worked out in the preceding discussion also supply a basis for estimating the maximum population that may be maintained by our existing land resources, assuming no greater relative dependence on imports than at present. Starting with the per capita acreages required under the extreme economies represented by the pre-war German standard of food and timber consumption, and allowing for the maximum economies in production shown to be possible by European experience, we may estimate the minimum acreage required per capita for the several uses. The sum of the per capita areas for crops and humid pasture divided into the total area available for these purposes will indicate approximately the maximum population under these assumptions. However, it is necessary to make allowance for the fact that the area of semiarid pasture will be not only about 119,000,000 acres less than at present, but, together with woodland, will carry proportionately a much smaller part of the total livestock units, even allowing for an increase of 50 per cent in its carrying capacity, thus throwing a somewhat greater burden on humid pasture.

When all these allowances are made a maximum population of 350,000,000 is indicated.[64]

Another method of estimating maximum population is by means of the areas per capita employed for crops and pasture in Germany. Of course, Germany was more dependent on importation than we are in the United States (fig. 57). In the case of 10 principal crops largely grown in the country, a careful estimate indicates that Germany was about 79.3 per cent self-sufficient in crop production.[65] No

[64] The method of calculation was as follows: The per capita area of humid pasture other than woodland that would be required under the German standard of consumption, if no semiarid or woodland pasture was available, was calculated on the basis of relative carrying capacities of the several classes of pasture. This per capita figure was divided by 2.22 to allow for a potential increase of 122 per cent in carrying capacity. The per capita crop area under the German standard of consumption divided by 1.468 to allow for a potential increase of 46.8 per cent in average yield was added to the per capita requirement of humid pasture, and this sum was divided into 1,004,000,000 acres, indicating a provisional population of 330,000,000 people without allowing for use of semiarid and woodland pasture. This allowance was made as follows: The number of livestock that would be carried on the area of semiarid land capable of being used only for pasture was estimated on the basis of present carrying capacity. This was increased by 50 per cent to allow for potential increase in carrying capacity, and the resulting number added to the number of animal units carried on woodland pasture. The total was then divided by the number of animal units per capita required under the German standard of consumption. This gave the number of people that could be provided for by the available semiarid and woodland pasture. This number divided by the per capita requirement of humid pasture under the assumed economies in consumption and production, as previously calculated, indicated the area of humid pasture to which the semiarid and woodland pasture would be equivalent. This equivalent was added to the 1,004,000,000 acres and the sum divided by the total per capita requirement of crop land and humid pasture.

[65] On the basis of calories for human consumption, including animal products used in the diet, it is estimated that Germany was about 85 per cent self-sufficient.

estimate is available for the degree of self-sufficiency in pasture production; but if this be assumed to be the same as for crops, the per capita requirement for Germany was approximately 1.4 acres of crops and pasture (other than woodland) per capita. Assuming that Germany was 80 per cent self-sufficient in the years just preceding the World War, the per capita acreage required to maintain her

PER CAPITA ACREAGE IN CROPS, HUMID PASTURES (AND EQUIVALENT), AND FORESTS USED FOR DOMESTIC CONSUMPTION, UNITED STATES, FRANCE, AND GERMANY.

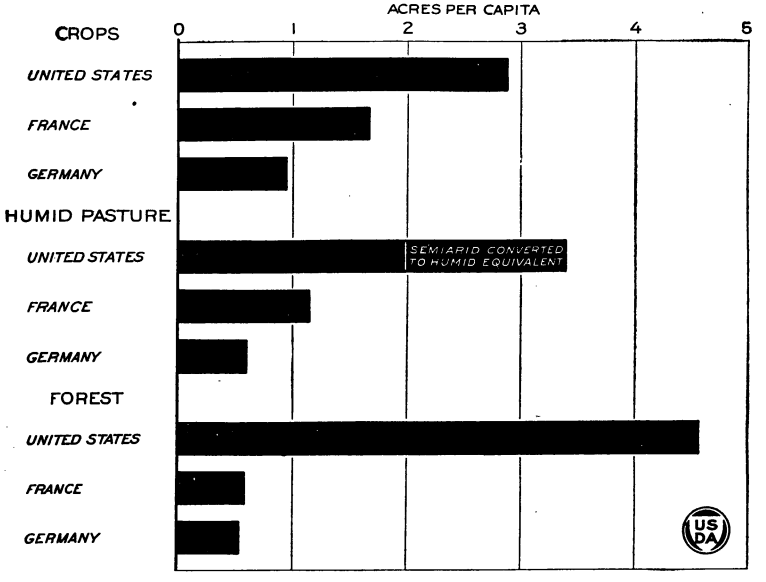

FIG. 57.—The acreages of crops and humid pasture for the United States do not include land employed in producing for export. No allowance is made for the acreage in France and Germany that would be required to produce the farm products imported. The column showing pasture area per capita for the United States includes an allowance for semiarid pasture converted to terms of humid pasture on the basis of relative carrying capacity. In all of the countries some use is made of forest for pasturage of livestock. In comparing the forest area per capita of the United States with the corresponding figures for the two European countries it is important to note that the former country is cutting largely from a stored crop, while the forest acreage of the two European countries is employed mainly in growing annual crops of timber. Furthermore, nearly 17 per cent of the so-called forest area of the United States consists of cut-over land not restocking.

population under the average conditions of production prevailing in that country was about 1.75 acres. After excluding land required for cities and other nonagricultural uses,[66] the area of land usable only for semiarid pasture or for forests, and waste land, there would remain a total of about 1,004,000,000 acres. On this basis our land area available for crops or humid pasture could be made to maintain a population of 574,000,000 people, even if no allowance be made for the additional aid supplied by our semiarid pasture.

The large difference between the two estimates is due to the fact that the first estimate was made on the basis of the assumption that the average yield per acre of crops may be increased by 46.8 per cent, which is based on averages for four European countries, with

[66] Including an allowance for the larger area required for our maximum population.

supplemental estimates for corn, hay, and cotton. The average, however, is considerably lower than the percentage by which the average yield of crop land in Germany exceeds the average for the United States. However, on account of the large area of semiarid crop land, it is very improbable that we could attain the average yields of Germany throughout our crop area. Consequently the average yields for the four countries previously employed is a more conservative basis of estimate. If allowance be made for the differences, a maximum population of about 345,000,000 is indicated.

This would seem to indicate that the preceding method of estimate is reasonably sound. As a matter of fact, both methods exaggerate somewhat the probable maximum population, or saturation point, for a number of reasons.

In the first place, the 1,004,000,000 acres of land available for crops and humid pasture includes all land that is physically capable of being employed for crops and pasture (not counting semiarid pasture). About 105,000,000 acres requires drainage or irrigation and includes large areas of land for which the expense of reclamation would be enormously costly; in other words, it is physically reclaimable but probably not economically available even under the pressing demands of a dense population. Again, the total area of 1,004,000,000 acres includes much land of low productivity either because of the character of the soil or because of aridity. It may be granted that the pressure of population would justify the expenditure of labor necessary to make and keep the poor soils of the humid region as productive as the average soils now in use will be made when necessity compels, but the total area includes more than 120,000,000 acres of semiarid land that probably can never by any economical expenditure of labor be made to produce on the average more than a fifth of the potential average product on the other lands of the United States. If these allowances be made and the available productive area be reduced to the equivalent in potential productivity of the area now in use under intensive agriculture, the available acreage would be about 908,000,000 instead of 1,004,000,000. On the former basis, the maximum population maintainable according to the first method of estimate would be about 319,000,000, while on the basis of the German requirements in per capita acreage it would be about 519,000,000. However, if the allowance be made, as above, for the difference in average yield of crop land for Germany as compared with the average for the four European countries, the maximum population would be about 312,000,000. Probably, all things considered, the maximum number maintainable under the standards of consumption prevailing in pre-war Germany and of production in the four European countries previously discussed would be not far from 300,000,000 people.[67] This would involve a severe reduction in

[67] By a study of the relation of cultivated acreage to population in Germany, France, and Belgium, Prof. E. M. East has concluded: "The maximum population the United States can support under any conditions conceivable to those of us who live at the present day, therefore, is 331,000,000." "The Agricultural Limits of Our Population" in The Scientific Monthly, XII, No. 6, p. 555. By an entirely different method of calculation—that is, by the projection of a population curve—Profs. Raymond Pearl and L. J. Reed have reached the conclusion that our maximum population will be 197,000,000. "On the Rate of Growth of the Population of the United States since 1790 and its Mathematical Representation" in Proceedings of the National Academy of Science, VI, pp. 275–286. If the population should become stationary at the figure suggested by Professor Pearl it would be due to economic and social motives working to limit population, rather than to the physical incapacity of our land resources to maintain a larger number.

general standard of living because of the heavy costs of utilization; and consequently the so-called saturation point, that is, the point beyond which population would no longer increase, may be reached considerably short of 300,000,000.

Conclusions.

The Problem of Forest Utilization.

The data that have been presented have indicated that during the next forest cycle an area of humid land as large as the present acreage of forest and cut-over land will not be needed for crops and pasture. An area of this magnitude would include not only the lands unsuitable because of hilly conditions or rough surface for any other use than forests, but also practically all of the sandy lands in the humid portion of the country and even a few million acres of the heavier soils. Probably small portions of this great area with special advantages in access to market may be devoted to trucking and fruits, but it would appear to be the part of wisdom to regard the area as a whole as suitable only for forest land during at least the next forest cycle of, say, 50 years and to take the necessary steps for reforesting as much of it as practicable.

This task is too large to leave wholly to private initiative and too urgent to leave to economic chance. Our forest wealth has melted away before our immense agricultural and industrial development, which caught us unprepared to take this fundamentally new step in our development, the cultivated forest. Only a beginning has been made in changing the national point of view from the idea of wasteful and unrestricted use to the idea of careful forest husbandry based mainly on the principle of growing our annual supply. Still less has been the advance in better forest management itself, for, aside from the one-fifth of our forest area in public ownership, relatively minor progress has been made either in stopping forest devastation or in the elementary steps toward adequate reforestation. Meanwhile, without a drastic and immediate change in policy, there looms a sharp curtailment of timber consumption below anything our population or our industries can easily be adjusted to. It is therefore obvious that a comprehensive policy is needed, the main elements of which may be stated as follows:

The growth problem.—Some of our public forest lands have not yet been brought under management for continuous timber production. This should be done as rapidly as possible. In order to help tide over the era of timber shortage, the standard of productivity of all public forests should be increased by better protection from fire, insects, and disease; by a more adequate technical service both in forest research and in forest management; and by large-scale planting of now idle lands. As our public forests are largely in Federal ownership, this is chiefly a Federal problem.

The problem of increasing the yields on private lands is much more complex and difficult. One large part of that problem is the better handling of our 150,000,000 acres of farm wood lots. The first essential step is to educate the farmer to apply to his wood lot the same idea of continuous cropping that he applies to his

fields. He will have to learn to use selective cutting, to exclude or restrict grazing in his woodlands, and to keep out fire. He will need assistance in marketing his timber products and in obtaining cheap nursery stock for planting. Public leadership is needed in all these ways.

Increasing the yields of private lands implies first of all that the public will step in and put a halt to forest denudation. Irrespective of who will in future own these lands or who will harvest the final crop, the present owner must be required, in cutting his timber, to leave the land in productive condition, that is, restocked or restocking with young growth. To permit him to do this, however, with a reasonable chance of profit, the public must do its share to reduce the risks. The chief risk, fire, must be met by a concerted effort by the National and State governments and by private owners to reduce fires to the point where all forests have a fair chance of escaping destruction somewhere on the road from youth to maturity. The risk to the individual may also be lessened by providing an adequate system of timber insurance. The development of systems of credit adapted to the special conditions of timber ownership by private agencies is another thing needed for encouraging private initiative, especially for small holders. It is also essential to encourage the private timber grower by supplanting the present property tax on growing timber crops with a more efficient form of taxation. The property tax is collected annually even though the crop may not be ready to sell for many years, and will be increasingly burdensome as private reforestation becomes more general. A third way in which public agencies can help increase yields is through more adequate research in methods of timber growing and forest management, and by educational efforts to get those methods into use.

The waste problem.—Public leadership is needed to reduce the large waste of merchantable timber from fire, insects, disease, and windfall. Still larger are the problems of wood waste in manufacture and use, all the way from the woods to the finished product. These problems require research and public leadership on a larger scale than we have at present.

In short, the forest problem requires rapid action on a large scale, for we are compelled within a few years to effect a veritable revolution in the point of view and methods involved in the utilization of land for forests.

The ownership problem.—It is desirable to develop private enterprise in forestry as rapidly as possible, as outlined above, but it is well to recognize that we should not rely on this as the major means of providing for the era of prospective shortage. Time is necessary to develop the requisite interest, and the potent stimulus of high values for timber and timber products is becoming influential only gradually.

To meet the need for rapid action within the next few decades to make provision against the severe shortage that is in prospect it will be necessary to rely heavily on public ownership and operation. The public forests—Federal, State, county, and municipal—now constituting only about one-fifth of our forest area should be largely in-

creased (fig. 58). Of our 483,000,000 acres of forest and cut-over land half should be in public ownership. This would involve an increase of 150,000,000 acres, or several million acres each year.

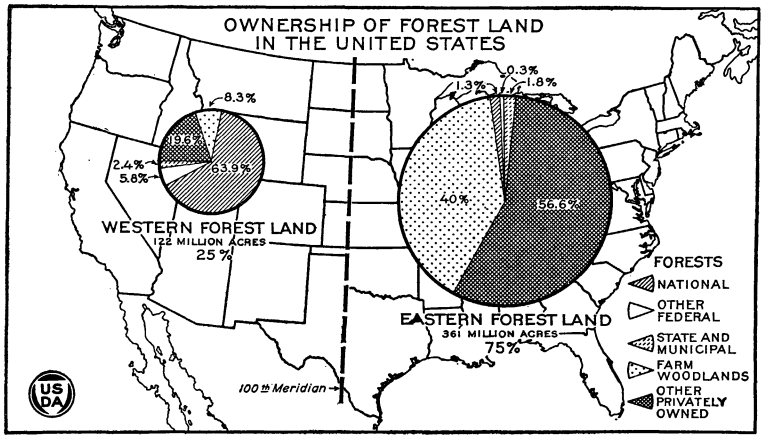

FIG. 58.—In the eastern forest region, which comprises 75 per cent of the total forest area of the United States, the national forests are only 1.3 per cent of the total, and all publicly owned forest land in this region is only a little more than 3 per cent. Two-fifths of the area is in farm-wood lots and the remainder consists of privately owned forests. In the western region about 70 per cent of the forest area is owned by the Federal Government, while 28 per cent consists of privately owned forests.

Land Classification Essential to the Systematic Selection of Land for Crops, Pasture, and Forests.

The above conclusion implies that the areas that are to be devoted to reforestation, as well as the areas that should be reserved during the next forest cycle for pasture and for crops, should be determined by deliberate selection. To this end it has been recognized for some time that a systematic classification of our reserve land area is requisite. Such a classification would serve not only to separate farm land from forest land in humid regions but also to distinguish farm land from range land in semiarid regions, and this would afford a basis for systematic direction to the necessary expansion of American agriculture.

The Misdirection of Agricultural Expansion.

Land settlement no longer consists of the spontaneous migration of population to virgin public lands of high quality. At present it is largely induced by the ceaseless activity of various classes of land-selling agencies seeking to profit by the sale of land. Owners of land however unsuitable for farming, are strongly impelled through the constant pressure of taxes and other carrying charges to sell it if possible. Local communities appear to benefit by the immigration of settlers even if they are unsuccessful in maintaining themselves on the land, and the unsuccessful settlers themselves are often eager to "unload" on another wave of immigrants. If outside in-

vestors or public agencies can be induced to undertake works of reclamation, there results at least a temporary increase in community prosperity as a result of the expenditure of the funds in the community. Furthermore, experience has shown that with sufficiently strong selling methods it is possible to find buyers for land entirely unsuitable for farming.

These forces and methods have resulted in the continual misdirection of land utilization and settlement. Land that should be kept in forests for at least the next forest cycle has been forced into occupation by settlers. Large areas in the West, more suitable for grazing than for crops, have been sporadically settled to the detriment of the established range industry.

The misdirection as to time and rate of settlement has been no less costly than the misdirection as to place. Settlement activity is always most extensive at times when agriculture is "booming." At such times, when land values are inflated and costs of reclamation, buildings, livestock, and machinery are at high levels, settlers in large numbers incur these high costs only to be compelled shortly to enter a period of depression under a heavy load of indebtedness.

Tendency to Overexpansion of Agriculture.

Furthermore, as a result of the desire of settlers to benefit by increase in land values, stimulated still more by the activity of agencies striving to effect the sale of land, expansion in land area tends to run ahead of the need for land. The evil results of this tendency are manifold. The enormous losses incurred by settlers in abortive attempts to obtain a foothold on the land and the consequent disappointment and disillusionment are paralleled by the losses of financial agencies engaged directly or indirectly in promoting land settlement. But even more serious is the tendency to lower the average level of profitableness for the established farming industry.

So continuous has been this tendency to overexpansion throughout the period of our national development that there has come to be a sort of cynical resignation to the evils involved and an acceptance of them as the inevitable price of national expansion. This is reflected in the widespread belief that at least three waves of settlers are necessary in order to settle a new region. Sometimes the attempt is made to justify the costliness of our let-alone policy in land settlement by pointing to the rapid expansion and growth in national area, population, and wealth. It should be recognized, however, that our tremendous progress has been due to our unusual advantages in national and in human resources, and would not have been seriously checked by reasonable restrictions designed to give direction to the currents of expansion and to reduce somewhat the wastefulness and costliness of the process.

In order to justify a policy of expansion without reference to whether basic economic conditions are favorable or unfavorable to such expansion, much is made of the sentimental argument, "We need more farm homes." To this one might make the somewhat oracular reply, "We do not need more farm homes than farms"—that is, it is useless to multiply farm homes which can not be adequately supported by the farms, and particularly to multiply them

under schemes which involve the assumption of heavy indebtedness by the farmers.

Driven from the sentimental position just described, the advocates of undue expansion sometimes resort to the suggestion that there can not be too many farm homes in which the family is fed from the farm. This is intended to justify the increase of farms on the ground that self-sufficing farmers will not compete with farmers already established. However, if the new farmers are persons now engaged in industry, their diversion to farming must result in increasing the competition of existing farmers, for a certain number of consumers are thereby brought to produce their own food. If the new farmers are immigrants from abroad, they bring their consuming power with them, it is true, but they will not long be content to remain where they get nothing but food and hard work. Moreover, the establishment of self-sufficing farm homes by any policy involving reclamation or other initial capital expenditures is practically out of the question if the costs must be assumed by the purchaser of the farm.

Some advocates of undue and ill-timed expansion of the farming area of the nation accept the assumption already mentioned that such expansion is inevitably wasteful and attended by heavy financial losses to those who undertake it, and on the basis of these assumptions boldly argue the necessity of a policy of subsidizing expansion. It should be pointed out, however, that it is the tendency toward the over-expansion of the farming area which, by reducing the profitableness of farming, makes the policy of subsidy necessary. The subsidy tends to overstimulate the expansion of the farming area, and this in turn makes the subsidy increasingly essential. Thus, like a drug addict, we must go on and on increasing the dose.

Need for Systematic Direction to Agricultural Expansion.

In order to prevent as far as possible the evils of over-expansion and misdirected expansion it would be necessary to develop a policy of unified and systematic direction to land settlement.

Such a policy would be, in general, essentially different from the land policies of the past. For more than a century the characteristic policy was the distribution of the public domain among private individuals, with little or no reference to the need for the land or the suitability of land for settlement. Since the passing of this phase of our land policy the most important feature of our policy of land settlement has been the reclamation system. This policy has been carried out with little attempt to relate the rate of reclamation to the Nation's needs for farm land. Moreover, in its application the policy has been sectional rather than national, and in some cases the areas settled have not been best adapted to the development and maintenance of successful agriculture. This tendency has been increased by the indirect subsidy involved in the exemption of settlers from interest on construction costs, a subsidy which has been estimated at approximately $70,000,000.[69]

[69] An estimate by R. P. Teele, associate economist, Bureau of Agricultural Economics (Division of Land Economics).

In a national policy of directing land settlement due consideration should be given to the needs, both national and local, for land to be devoted to crops, pasture, and forests, and also to the relative advantages of all parts of the Nation for the various uses of land. Another important consideration is the economic value of wild life. In addition to the value of forests for timber production, it is important to consider their value in providing a home for many kinds of useful birds and other forest-loving animals; and in deciding upon the drainage of marshes and shallow lakes, their value in the natural state as breeding places of fish, birds, and fur-bearing animals should be adequately considered. The recreational value of wild lands, as well as their direct economic value in the wild state, should not be overlooked.

Clearly, the interests involved are too great to be left to chance, for the *let alone* policy of the past few decades has been a source of enormous economic waste, and social misery. Nor can such interests be left entirely to the individual States, for it frequently appears to be to the interest of a particular State to attract settlers from other States, with little reference to the bearing of such action on the national needs for the various uses of land or to whether the change is for the better from the standpoint of the welfare and efficiency of the settlers.

In view of these considerations, emphasis is given to the suggestion of the National Agricultural Conference of 1922 that some Federal agency be granted authority to work, in cooperation with the States, in giving systematic direction to the expansion of American agriculture, on the basis of a scientific land classification.

Importance of Taking Steps to Increase the Productivity of Crop and Pasture Land.

The facts presented in this article emphasize the importance of increasing somewhat the productivity of crop and pasture land, if the requirements of expanding population during the next few decades are to be met. To a large extent this progress must be achieved through the aid and stimulus afforded our farmers and ranchmen by means of research and extension activities. However, in the case of the large area of public land now used as open range, it is generally recognized that the present system of unrestricted free use of these lands is lessening the value of large areas of grazing land and is seriously crippling the range stock industry. The effect of the enlarged homestead and grazing homestead acts was to still further demoralize the industry. It is believed that by creating grazing districts operated under a permit system of regulated grazing, as in the national forests, an increase in the carrying capacity such as has been accomplished in the national forests could be achieved.

Need for Administrative Unification of National Land Policy.

A consideration of the group of programs that have been suggested above indicates that they can not be regarded as isolated policies, each of which can be effectively carried out by separate agencies. On the contrary these policies are closely interrelated, and

the essential need is for a unification in the future development of our national land policies. Unfortunately during the past 100 years the different functions connected with land policy have been distributed among various governmental agencies. As one looks into the future, however, it becomes apparent that we are entering an economic era in which the various functions involved in working out the new policies are vitally interrelated, requiring unification in administration. Only by such unity of policy and of execution can ill-considered and excessive expansion and rapid but wasteful utilization be supplanted by deliberate selection, careful economy, and constructive development with due reference to the long-time requirements of the nation.