STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

PUBLICATIONS OF THE
DIVISION OF WATER RESOURCES
EDWARD HYATT, State Engineer

Reports on State Water Plan Prepared Pursuant to Chapter 832, Statutes of 1929

BULLETIN No. 35

PERMISSIBLE ECONOMIC RATE

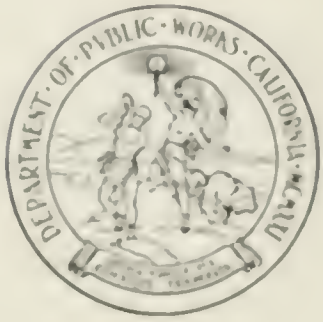
OF

IRRIGATION DEVELOPMENT

IN CALIFORNIA

A Cooperative Report by the College of Agriculture,
University of California.

1930



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LETTER OF TRANSMITTAL

Mr. Edward Hyatt,
State Engineer,
Sacramento, California.

Dear Sir: I transmit herewith a manuscript entitled "Permissible Economic Rate of Irrigation Development in California," by David Weeks.

This is one of the reports which you requested the College of Agriculture to prepare for you dealing with certain economic aspects of the state water plan.

You will recall that I appointed a committee from our staff to confer with you in connection with outlining this work, it being understood that this committee would also review the report prior to its being forwarded to you.

This committee has carefully reviewed this manuscript and recommends its transmittal to you. It approves the manuscript as presenting a reasonable analysis of the factors governing trends in our agricultural development and our needs for agricultural land, particularly intensively cultivated irrigated land.

I trust that the report will be found to cover the ground you had in mind when referring the matter to the College of Agriculture.

Very sincerely yours,

C. B. Hutchison

Dean, College of Agriculture.

Berkeley, California,
October 30, 1930.

ACKNOWLEDGMENT

A work of this kind covering such a wide scope naturally could not be that of a single individual. The staffs of the Division of Water Resources of the State Department of Public Works, the Agricultural Economics and Extension Divisions of the University of California and of the Giannini Foundation have generously contributed valuable information. Especial mention should be made of the contribution of certain individuals without which the report could not have been written. These include data compiled especially for this investigation by E. E. Kaufman and Geo. A. Scott, the Cost of Production Studies by Professor R. L. Adams and L. W. Fluharty, the Studies of Fruit Production by Dr. S. W. Shear, and the Economic Studies of the Live Stock Situation by Professor E. C. Voorhies. The active cooperation of Edward Hyatt, State Engineer, and Dean C. B. Hutchison of the College of Agriculture of the University of California, represents a new step of progress in placing the research facilities of the University at the disposal of those responsible for determining state policy. The assistance rendered by the State Engineer's office made possible the analysis in Chapter VIII and the preparation of the drawings of the entire report. The assistants of the College of Agriculture who have been employed directly in the investigation should also receive recognition for important contributions. Harold Hotlich assisted in determining land requirements for the live stock industry, Frederick Church on the population problem, Lorna Finch on the index of agricultural production and the predictions of future requirements, and Edna Fisher in the land utilization analysis.

ORGANIZATION

STATE DEPARTMENT OF PUBLIC WORKS

B. B. MEEK.....*Director*

EDWARD HYATT.....*State Engineer*

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ORGANIZATION

UNIVERSITY OF CALIFORNIA, COLLEGE OF AGRICULTURE

Cooperating in

Water Resources Investigation

C. B. Hutchison ..... *Dean, College of Agriculture*

This report was prepared by

David Weeks

Associate Professor of Agricultural Economics,

with the advice and cooperation of the following committee appointed by the Dean of the College of Agriculture:

Frank Adams

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Assistant State Leader Agricultural Extension Service

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Specialist in Agricultural Extension

CHAPTER 832, STATUTES OF 1929

An act making an appropriation for work of exploration, investigation and preliminary plans in furtherance of a coordinated plan for the conservation, development, and utilization of the water resources of California including the Santa Ana river, Mojave river and all water resources of southern California.

[I object to the item of $450,000.00 in section 1 and reduce the amount to $390,000.00. With this reduction I approve the bill. Dated June 17, 1929. C. C. Young, Governor.]

The people of the State of California do enact as follows:

Section 1. Out of any money in the state treasury not otherwise appropriated, the sum of four hundred fifty thousand dollars, or so much thereof as may be necessary, is hereby appropriated to be expended by the state department of public works in accordance with law in conducting work of exploration, investigation and preliminary plans in furtherance of a coordinated plan for the conservation, development and utilization of the water resources of California including the Santa Ana river and its tributaries, the Mojave river and its tributaries, and all other water resources of southern California.

Sec. 2. The department of public works, subject to the other provisions of this act, is empowered to expend any portion of the appropriation herein provided for the purposes of this act, in cooperation with the government of the United States of America or in cooperation with political subdivisions of the State of California; and for the purpose of such cooperation is hereby authorized to draw its claim upon said appropriation in favor of the United States of America or the appropriate agency thereof for the payment of the cost of such portion of said cooperative work as may be determined by the department of public works.

Sec. 3. Upon the sale of any bonds of this state hereafter authorized to be issued to be expended for any one or more of the purposes for which any part of the appropriation herein provided may have been expended, the amount so expended from the appropriation herein provided shall be returned into the general fund of the state treasury out of the proceeds first derived from the sale of said bonds.

FOREWORD

This report is one of a series of bulletins on the State Water Plan issued by the Division of Water Resources pursuant to the provisions of Chapter 832, Statutes of 1929, directing further investigations of the water resources of California. The series includes Bulletin Nos. 25 to 36, inclusive. Bulletin No. 25, "Report to Legislature of 1931 on State Water Plan," is a summary report of the entire investigation.

Prior to the studies carried out under this act, the water resources investigation had been in progress more or less continuously since 1921 under several statutory enactments. The results of the earlier work have been published as Bulletin Nos. 3, 4, 5, 6, 9, 11, 12, 13, 14, 19 and 20 of the former Division of Engineering and Irrigation, Nos. 5, 6 and 7 of the former Division of Water Rights and Nos. 22 and 24 of the Division of Water Resources.

This bulletin is one of two reports dealing with certain economic aspects of the State Water Plan prepared by the College of Agriculture, University of California.

The rate at which additional supplies of water will be needed for the irrigation of California lands is an important matter and has been the subject of an intensive study during the present investigation. Present and future construction of irrigation works should be planned so that California agriculture would be safeguarded against over-expansion. This report presents an analysis of past and future demands for California agricultural products, taking into consideration the past and probable future growth of population of both the State and United States, and an estimate of the requirements for irrigated lands in California in the next four decades.

CHAPTER I

INTRODUCTION AND SUMMARY

California's irrigation development is inextricably bound up with her population growth, the growth of her live stock industry, her demonstrated superior advantage in the production of fruits and vegetables, and most particularly the geographical position and character of her land and water resources. The advantages which the state possesses, however, have worked in some respects to increase the difficulties of a stabilized growth.

Irrigation works built in response to favorable financial conditions and optimism of one period become wholly out of proportion to the needs of later periods of low prices. The length of time required to build irrigation works, obtain settlers, prepare the land for irrigation, install the necessary improvements, and finally to set the production machinery into operation is so great, that nature's check of reduced prices resulting from a surplus is retarded, but meanwhile construction of projects continues until the belated check does come. California's most important agricultural industry, the production of orchard and vineyard fruits, expands its acreage in response to favorable prices until checked by the stress of a surplus. This check comes from three to five or more years after the acreage which will create a surplus has been planted. This is the period of time required for fruits to come into bearing. In the meantime the orchards and vineyards continue to be planted. The period of pessimism which follows generates a shortage which in the long run may be just as detrimental as the surplus. Data available on United States fruit production show that the last two periods of maximum per capita production were about eleven years apart. While this economic phenomenon operates in other states entirely independent of irrigation, in California the fruit production cycle is a disturbing element when superimposed upon the other vicissitudes which beset irrigation development.

Another characteristic of irrigation which is not peculiar alone to California, but is a common cause of difficulty wherever irrigation is practiced on a large scale, should be mentioned. The modern irrigation project is usually of such magnitude, because of the character of available water supplies, that there is made available more land than may be needed immediately upon the completion of the project. This land at once incurs the obligation of repayment of the project cost, and becomes a menace to the maintenance of equilibrium in the supply of agricultural commodities, even upon a growing market, as the overhead cost of carrying it as undeveloped land greatly increases the ultimate cost of irrigated land.

The State Plan of Water Conservation.

A situation exists in the four upper counties of the San Joaquin Valley which is the result of the agriculture of the community having outgrown its water supply. This situation has become most serious in Tulare County, where about 350,000 acres have been put under irrigation, for which most of the water is taken from the underground supply

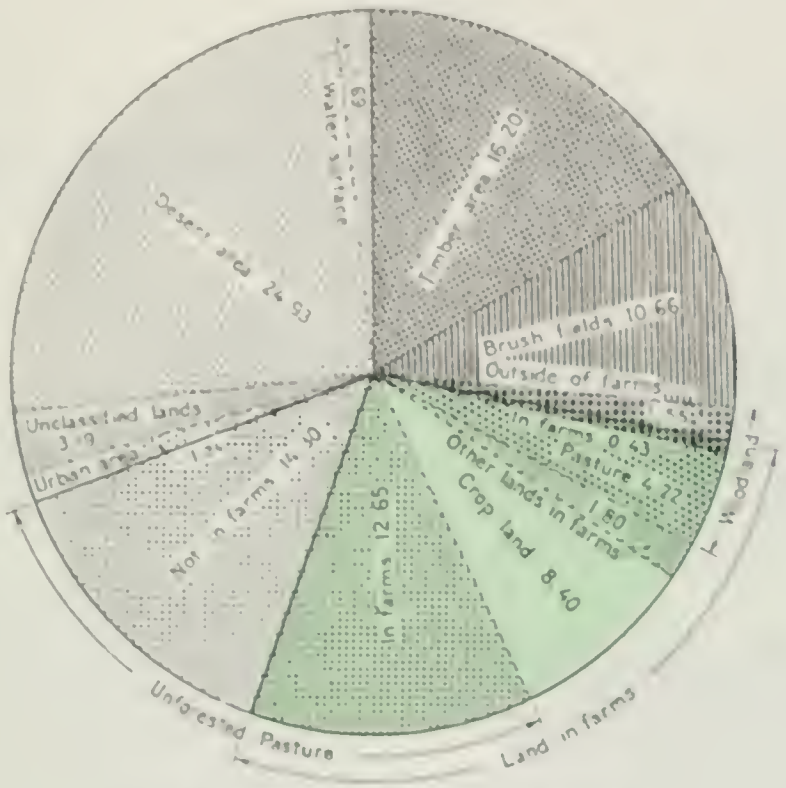
by means of wells. Year by year ground water levels have receded, the cost of pumping has increased, and finally orchards have been abandoned. To deliver additional supplies to the area, the conveyance of water from distant sources will be necessary, and because of the highly intensified agriculture of the locality any irrigation project that will deliver water to the area will be looked upon with favor, even though the resulting costs are high. Engineering investigations have shown that unusual difficulties must be surmounted to meet the emergency. One plan would be to provide a full supplemental supply from the surplus waters of the Sacramento River Basin. This water would be stored and later transported by means of the gravity flow of that stream and a series of pumps designed to carry it to the San Joaquin. Finally by means of exchange with existing irrigation projects, in which the pumped water from the Sacramento River would be traded for supplies nearer the headwaters of the San Joaquin River system, the water of the Sacramento River, stored at the opposite extremity of the great interior valley, will have served the orchards of Tulare County.

Broader Aspects of the Problem.

The present emergency in the upper San Joaquin Valley, however, is only one phase of the state water conservation plan. It is true that the pressure exerted by those now badly needing water in this area has brought to an issue a matter which has been pending for many years. There are approximately 6,860,000 acres of unirrigated irrigable land in the two interior valleys which will come into the picture at some point in the plan of future development. The rate at which these lands are likely to demand a water supply will have an important bearing upon the immediate problem of providing water for lands already intensively cultivated but which have inadequate supplies.

Intimately related to the irrigation problems of the Sacramento and San Joaquin valleys are the salt-water menace in the delta and Suisun Bay, the flood-control problem, hydro-electric power development and sale, navigation and hydraulic mining. The many interests involved, the great complexity of the problem, and the necessity for investigation and research by many types of specialists, would require a special publication merely to describe the plan by which the different phases have been coordinated in a comprehensive program. Further comment upon these broader phases, therefore, will not be made and the remainder of this report will be confined to its specific objectives. These objectives probably can be most adequately described by quoting the opening paragraph of the outline of the investigation as approved by the State Engineer and the Dean of the College of Agriculture of the University of California. This paragraph reads as follows:

> A study is to be made of agricultural land requirements in order to determine the rate at which the new water supplies are to be developed to meet the increasing demand for California agricultural products. The points to be considered will include trends in the utilization of land, trends in the development and use of water supplied and in the area of irrigated land, analyses of the causes of changes in land utilization, population growth, available land areas, and the areas of land that will probably be needed for various uses.

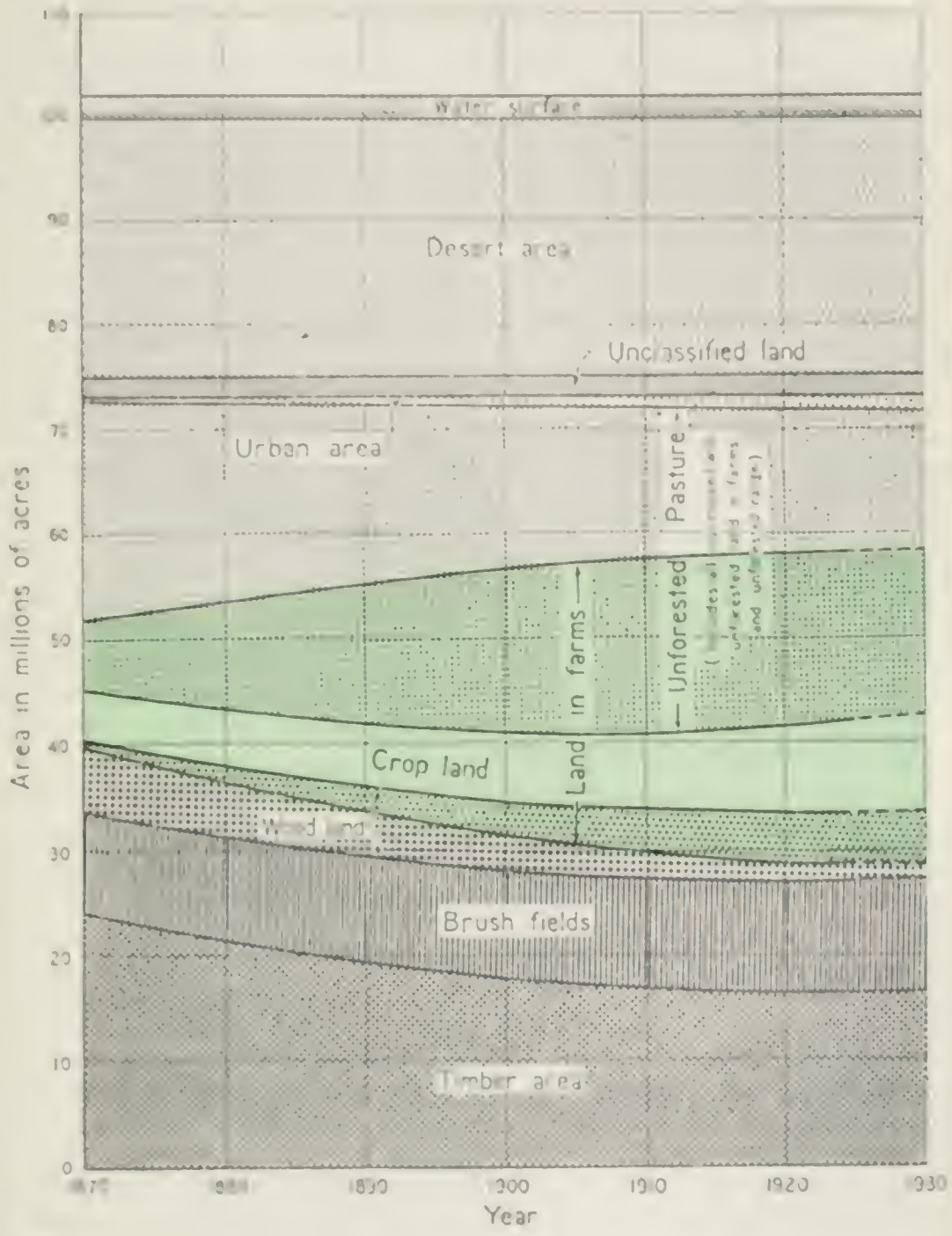


Area expressed in millions of acres

MAJOR USES OF CALIFORNIA LAND

IN

1925



TRENDS IN THE

MAJOR USES OF CALIFORNIA LANDS

Trends in the Major Uses of California Land.

The land area of California is approximately 100,000,000 acres. Acreages expressed in millions, therefore, also indicate the percentages which each major use bears to the total. The gross area of the state is shown in Plate I,* which also gives the relative magnitude of the areas devoted to the various major uses in 1925. The different types of forest cover in that year comprised a third of the total, while desert, water surface, urban area, and miscellaneous unclassified uses comprised nearly another third. Agriculture occupied the remaining third, but a small part of this was devoted to harvested crops. Changes in the major land uses since 1925 have been slight. The great volume of California's harvested crop land products is produced on about 7 per cent of the total area of the state. The remainder of the agricultural area is taken up with pasture.

While crop land area has been gradually increasing in extent, the area in virgin timber has been decreasing. Even the broad and general classes of land utilization, therefore, can not be considered static. California's land problem is a dynamic one. This is brought out in Plate II*, which shows trends in the major uses of California land. In the past sixty years the timber area has been reduced 32 per cent, while the land in farms has increased 125 per cent and the crop land 90 per cent. Changes in the major utilization of land over a long period of time may have an important bearing upon the total volume of agricultural production, especially when the live stock industries are considered.

Crop Land Utilization.

During the past twenty years the area of land in farms has not expanded and the cropped area has increased only 15 per cent. There have been outstanding changes, however, in the utilization of the crop land. Notwithstanding this small increase in the crop land area, agricultural production has more than doubled. California population in the meantime has followed or has been followed by the growth in agricultural production. Figure 1 of Plate III shows how nearly population growth has paralleled the trend in agricultural production.† Figure 2 of this same plate shows that it has been the expansion of our fruit acreage which has been largely responsible for the phenomenal growth in our agricultural production, for it will be seen that neither the acreage of total crop land harvested nor the acreage of alfalfa have had rates of increase as great as population, while the fruit acreage has kept well ahead of population growth.

Will California Agricultural Production Continue to Parallel Population In Its Rate of Growth?

Contrary to popular impressions, the phenomenal growth of the California fruit industry has not been the result of permanent increases in the per capita consumption nor a rapid increase in foreign shipments.

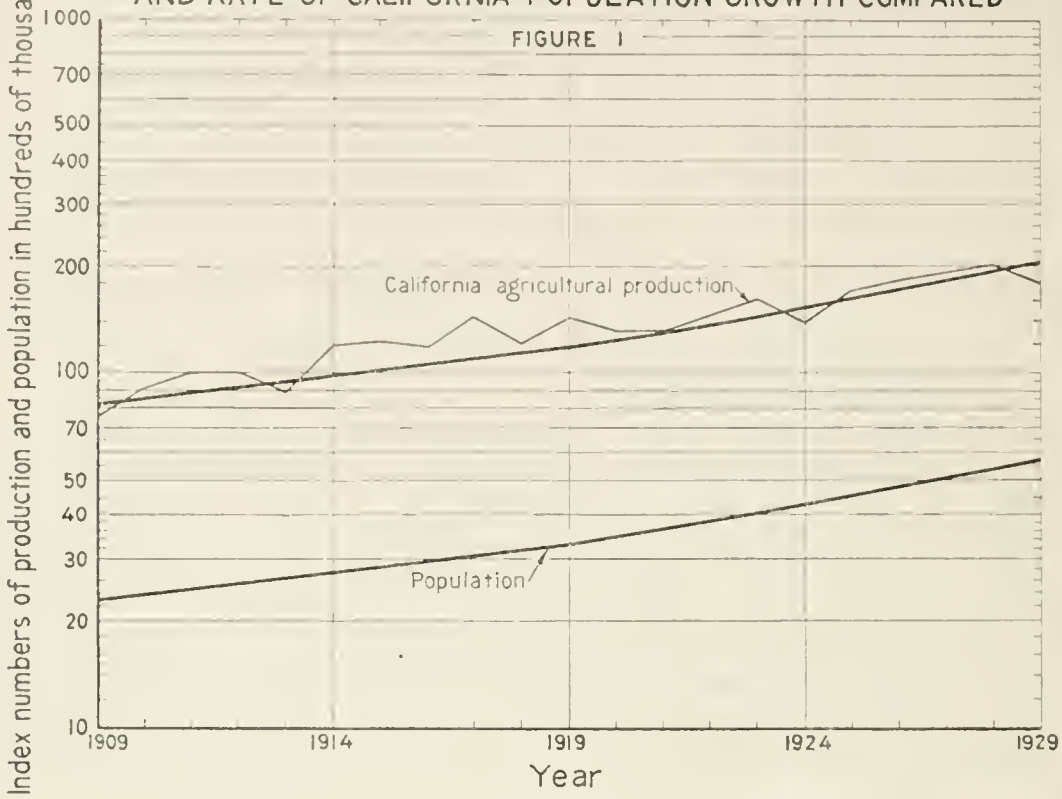
* The construction of Plates I and II has been made possible by the research of Mr. T. I. Li working under the direction of the writer.

† Based also on index of agricultural production, which is a composite of the relative rate of increase in the production of 20 commodities from 1909 to 1921 and 22 commodities from 1915 to 1925. The data from which the plate has been constructed are given in Appendix B.

Plate III

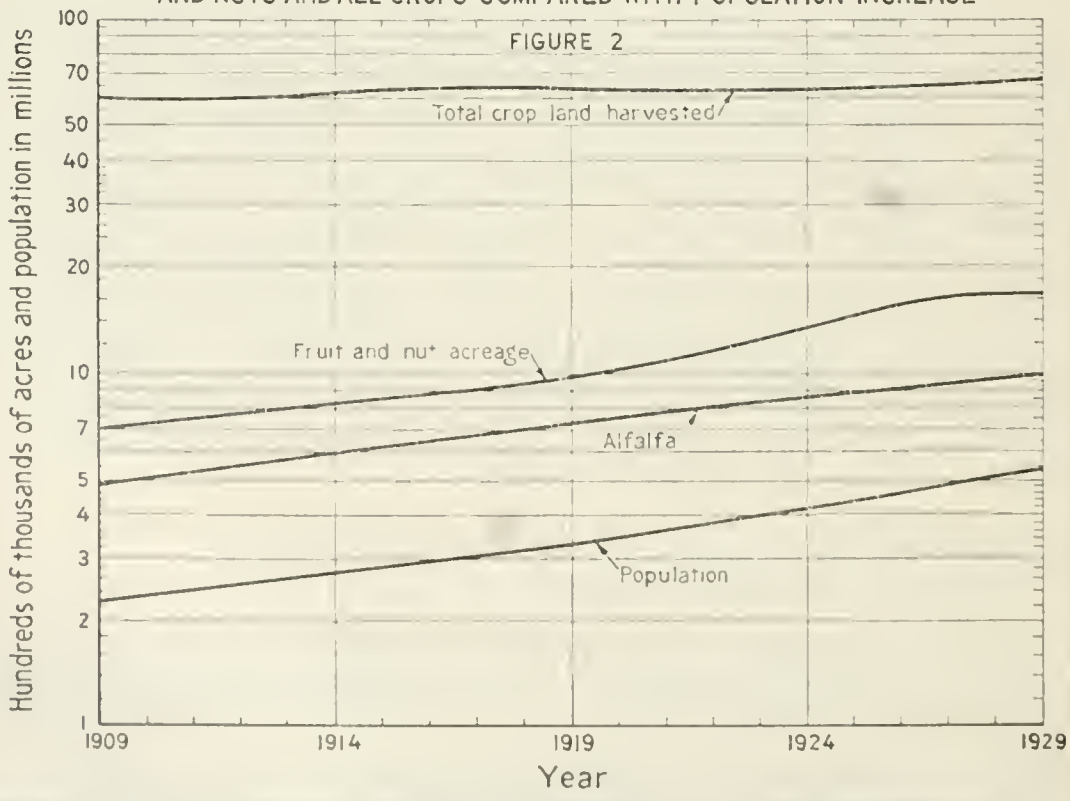
INDEX NUMBERS OF CALIFORNIA AGRICULTURAL PRODUCTION AND RATE OF CALIFORNIA POPULATION GROWTH COMPARED

FIGURE 1



RATES OF GROWTH IN THE CALIFORNIA HARVESTED ACREAGE OF ALFALFA, FRUITS AND NUTS AND ALL CROPS COMPARED WITH POPULATION INCREASE

FIGURE 2



There has been some increase in United States per capita consumption in recent years, but most of this increase has probably been cyclical in its character, largely due to an abundance of fruit at low prices. The per capita production of all United States fruits in 1914 and 1915 was as great if not greater than during the past few years. The increase in California has been made possible by a shift of a greater and greater percentage of the United States production to California fruit farms. In twenty years we have doubled the ratio of California fruit production to that of the United States. During the past few years California production of orchard and vineyard fruits has averaged 45 per cent of the production of the entire country. The rate of increase of California fruit production can not keep up unless new trends are established in per capita consumption and foreign trade.

Population.

Trends of fruit production should be considered in the light of new knowledge recently developed by students of the growth and composition of the United States population. The rate of natural increase of the United States population is less than one-third of what it was in 1890, and because of changes in the composition of the population it is predicted that the rate of natural increase will continue to decline. Since the rate of United States population growth will remain for some time the dominant factor in determining the rate of expansion of the California fruit industry, these trends in United States population growth are significant.

There are positive elements in the picture, however, the most important one being the growth of California population. The population of the state has increased 138 per cent in the past twenty years and 65 per cent during the past decade. There has been an upward trend for many decades in the ratio of California immigration from other states and foreign countries, to the increase of United States population. Because of the large reservoir of population from which the increasing numbers of California population are drawn, the decline in the rate of growth in the United States population should not have an immediate and important effect in reducing California growth. Changes in the composition of the United States population have already had a marked influence upon the age and nativity composition in California. Realizing that many things may happen to change the trend of immigration suddenly, it seems reasonable, in the light of evidence presented in Chapter III, to expect a population in 1940 between 8,500,000 and 8,700,000, in 1950 between 11,500,000 and 12,500,000, in 1960 between 14,500,000 and 16,750,000, and in 1970 between 17,000,000 and 20,500,000.

Future Requirements for Irrigated Land.

Most of the estimates of the future need for farm land, made in recent years, have assumed a given population growth and food requirements for that population, giving consideration, of course, to trends in production per acre of crops and of live stock products and to foreign trade. The present report is no improvement over these earlier reports in regard to this particular point in method of procedure. It seems, however, that the results should be interpreted with the realization that

population growth, even in this enlightened country, may still be influenced by the relative ease with which it can produce its food supply. In other words, the future population of the United States, while greatly influenced by modern social standards, the growing love of independence from home duties, drudgery, and responsibility, will depend to some extent upon the relative scarcity of farm land of a quality that will compare with that already under cultivation and which can be put under cultivation at a cost in labor and materials that will not discourage those who attempt to develop new projects.

To supply our needs for food we have many alternatives so far as land utilization is concerned. In fact, we may use much land or little land as we choose, regulating the output of agricultural products by the amount of labor and capital we elect to put upon it. This flexibility is limited only by the relative cost of obtaining that production by the use of different amounts of land. As our population grows and our land becomes scarce we seek to obtain more products from the same area. This we have accomplished in California by irrigation, by increasing the output of butterfat per cow, and by other means. In general we have increased our output per acre only by making heavier and heavier investments. We have, of course, in many cases made definite advances in the efficiency of production. It is often very difficult to determine whether an increased production per acre is the result of an increased expenditure per acre or the result of improvement in methods of production. We have greatly reduced the amount of feed and hence the amount of land required to produce a pound of butterfat without materially reducing the cost.

The basic criterion, therefore, as to the demand for more farm land is that acreage should be added to just that extent which will provide the needed supply of agricultural products more cheaply than could be done by increasing the investment in labor and equipment on lands already under cultivation. This, of course, is the ideal. Available statistics do not permit of exact measurement of the elements which are essential to setting up such a criterion. All that can be done is to observe trends of per capita consumption, production, acreage, population, and efficiency of production, and in particular what the land resources are in comparison with land requirements. The results of such an analysis are given in the seven chapters following.

A word should be said here concerning the limitations of the estimates which have been made. Although for the most part rational analysis has been possible, in developing the results given in the final conclusions there have been many elements which have seemed almost impossible of determination. Many unforeseen changes in production and consumption may be expected. Aside from the uncertainty of future immigration into California, there have been certain aspects of the problem which have been very baffling. The estimate of future fruit production in the United States has not been involved in so many uncertainties as has been the estimate of the proportion of that total which may be expected to be produced within California. The upper and lower reasonable limits of the future ratio between California production and United States production are far apart, and the exact trend of California production between these limits will be governed not alone by the demand for fruit in the United States and foreign

countries, but will be very greatly influenced by the amount of production in competing areas, and to the extent that California becomes aggressive in taking over the fruit-production industry as her speciality. Forecasting these trends therefore involves assumption as to what California's policy is to be. California's action will have very much to do with the percentage of United States fruit production which will be produced within the borders of this state.

Similarly the live stock industry presents questions equally difficult. The estimates in this report have been based upon the assumption that present characteristics of supply and demand in the dairy industry will continue. It is almost certain that these conditions will not continue exactly as at present, but we have no basis upon which to estimate future changes in these intangible elements. There are many who do not believe that the acreage estimated for the live stock industry in this report will be required. Arguments to support this belief are numerous. If the tariff were suddenly removed on dairy products, there would be a terrific upset in the prices and values of dairy products.

With reference to the poultry industry, grave doubts arise in the minds of some as to whether we will have the maximum land requirements proposed. It is probable that over a period of years poultry production in the Mississippi Valley will come closer to the standard set by the California poultry business and that improvements in the technique of production will place that section of the country on a far better competitive basis than it is at the present time.

In the beef industry revolutionary changes in production are in the offing. In connection with both the sheep and beef industries increase in the efficiency of pastures constitutes a most uncertain element.

It must be recognized, however, that California producers will probably share with the rest of the country any advantages to be gained by increased efficiency of production. In the past, California has not been backward in extending her markets, introducing new enterprises, utilizing improved methods, and meeting new difficulties. If all of the contingencies which might beset California farmers in meeting the competition likely to be theirs in the future are to be taken into consideration, that indomitable spirit with which obstacles are surmounted and by means of which progress is made, also must be recognized.

The estimates as given should be used with full recognition of the uncertainty of the future. They are the best inferences possible on the basis of existing knowledge. It must also be pointed out that the trends indicated in the following chapters in general do not take into consideration violent variations from normal. Our business structure, as well as our agricultural industry, is subject to cyclical variations. We are now in a rather serious business depression which in itself will probably have a marked effect on the demand for agricultural commodities.

There is a large area of land within California irrigation and reclamation projects and on farms now partly irrigated by installed private pumping plants which is adaptable to irrigation but which is not now irrigated. This land is potentially available for early development, but the present economic status of industry and agriculture, increasing production per acre on land now under irrigation, and the possi-

bilities of development within competing areas, all point toward the conclusion that development which would involve bringing substantial areas of additional land under irrigation is not needed at this time.

If economic conditions affecting California agriculture improve early in the decade it is estimated that a half million acres can safely be added to the intensively irrigated area before 1940, but the acreage of unirrigated irrigable land within California projects is more than sufficient to take care of this expansion. During the decade beginning in 1940 it is probable that three quarters of a million acres might be safely added, but the significant trends in population and increasing costs of irrigation development indicate that in the two decades between 1950 and 1970 the optimum rate of growth will be somewhat less than this.

The statements given in this report are not expected to hold good in every respect over the entire period to which they pertain. Each step in our progress should be accompanied by a refinement of estimates as new data become available. The results of this investigation will have fulfilled their objectives if they point the way for making a start on a comprehensive program of development designed to assist in stabilizing agriculture rather than one which may endanger the price level.

Agriculture under irrigation constitutes such an important part of the total output for the state that those charged with the duty of determining the State's policy with respect to irrigation development have within their power the means of going a long way toward smoothing out the production cycles of the future and laying the groundwork for plans to prevent the disastrous price disturbances of the past. Such a policy will not be a purely negative one. Although in the past there has been a tendency to push irrigation development beyond the point required for supplying land as needed, irrigation expansion in the future will be retarded by the magnitude of the undertakings which will be necessary, and the expense involved in construction. To assist in carrying out the program of the future, more knowledge concerning the crop adaptations of our land, irrigated and unrrigated, will be required. More information concerning the comparative costs of increasing our agricultural output by more intensive utilization of lands now under irrigation and of constructing some of our major projects of the future, will be required.

CHAPTER II

POPULATION AND LAND REQUIREMENTS

More than 46 per cent of the people now living in California came here during the past decade. This is true notwithstanding the fact that only about 10 per cent of California's native sons and daughters moved permanently away from the state of their birth. This is a smaller percentage than is lost by any other state. Contrary to a common belief, this influx of immigrants from other parts of this and foreign countries is not of the aged and feeble seeking only the mild winters of the Pacific shores, but consists of men and women in the prime of life coming in search of opportunities for a livelihood. For fifty years the stream of immigration has brought several times as many between the ages of 20 and 40 as of all other ages combined. Thus it is that California with a crude rate of natural increase* smaller than that of any other state maintains a rate of growth not exceeded by any other. Complicated as it is with this uncertain factor of immigration, which in itself is responsible to a high degree for the disparity in rate of natural increase, California population growth must be better understood if we are to plan intelligently the public and private developments necessary to properly conserve our natural resources.

California population alone, however, will not give us the index we desire for an estimate of future requirements for irrigated land. In addition we must have an understanding not only of the probable rates of growth in numbers of the nation's people, but we must inquire into the probable effect of important changes taking place in the composition of the national population upon the future rates of growth in California. We might go farther and say the same of world population, but some device must serve our needs for an estimate of this broader influence which will reduce the amount of analysis to a scope within reach of available facilities.

Declining birth rates and unequal changes in rates of mortality among different portions of both our national and state populations are affecting the age composition to such an extent that an increasing percentage of older people has been in evidence for a number of decades in populations of state and nation; moreover the available immigrants are being subjected to a process of selection, the incoming group having on the whole a different age distribution than that of those among whom they had previously lived or of those who are already here. The rate therefore at which these people move to California has had, and will continue to have, a disturbing influence on the age composition of our California population and this in turn has affected, and will continue to affect, the rate of natural increase. These, however, are not all of the complications. Cyclical tendencies in our birth rate add to the difficulties of interpreting the extent of downward trend, and changes in sex ratios, ratios of numbers in the urban population to those of rural, native to foreign, and changes in our immigration laws and immigration law enforcement all make the establishment of tangible limits of future population growth in California most difficult.

* Crude rate of natural increase is the difference between births and deaths expressed as a percentage of the total population.

The question arises, as to whether it might not be foolhardy to attempt a forecast. The answer is that the importance of some attempt is as great as the difficulties involved, and all that is asked is clemeney on the part of those who in future years compare the results of this investigation with past events. It is hoped they will remember they are looking back and that this report is looking ahead through telescopes having lenses none too perfect, making use of such materials as are readily at hand. Furthermore, lest the work become available too late to serve the purpose for which it is intended, many short cuts have been made necessary. These have been taken, however, with the basic principles in mind and the estimates of future population are presented with a certain degree of confidence, subject of course to a sensible degree of caution in their application.

PRINCIPLES OF POPULATION GROWTH

A few more general statements should be made before entering upon the kernel of the problem. These concern the broad principles of population growth. It has been necessary to eliminate, for the want of space, a review of much of the work of others in this field. No serious work on population, however, fails to mention the work of Malthus and the long line of economists who have alternately sung his praise and condemned him. He wrote his statements in the light of the knowledge of his day and the worst that can be said of him is that he failed to take into consideration all of the factors that affect population growth. He certainly recognized some of the important elements we may be criticized for slighting. Among these may be mentioned natural resources. Other important phases of the problem which must be considered in an estimate of future population covering several decades are birth rates, mortality rates and immigration.

Natural Resources.

Population growth if not limited by some other cause certainly may be limited or stimulated by natural resources. In the present investigation agricultural land resources have been given as complete consideration as seems necessary. This is because they are the object of the study. Minerals, however, and water power have admittedly been left out of the picture except indirectly, as will be described later. Trade facilities and possibilities of commercial and industrial development and the intangible resources which in their various combinations make California such an attractive place to live, all contribute to the phenomenal growth which has taken place. Indirectly, however, these have all been taken into account by a study of their combined resultant effect upon the population, and it is in the trends of the population itself that they are reflected. In fact population growth is the most complete index available of the rate at which natural resources are capable of being developed. Some speculation should be made, however, upon the likelihood of these influences continuing at the same rate as in the past, especially in the light of other important elements at work having a more or less negative influence.

Birth Rates.

Changes in birth rates are significant from the standpoint of appraising estimates which have been made by others of future United States population and with respect to working out a basis of estimating decade by decade the future California child population. The sharp decline in the birth rate during and since the war has apparently been world wide. In Europe there has been a steady decline since 1876 in the number of births per thousand persons in the population. From an average birth rate of 32.8 births per 1000 in the population in the five-year period, 1876 to 1880, the rate fell to 19.2 in 1926.*

That a similar change is taking place in the United States has been pointed out in the following statement by Thompson and Whelpton of the Scripps Foundation of the Miami University:

> In the United States as a whole, the birth rate has been declining very rapidly of late years. Although this decline commenced over a century ago, it has been particularly marked since 1920. During the last eight years the birth rate has fallen from 23.7 a thousand of population to 19.7, or over one-sixth. The death rate, on the other hand, has fallen more slowly than the birth rate for some years, and since 1920 has scarcely fallen at all. The result is that a crude rate of natural increase of 10.6 in 1920, which appeared very low then, has fallen one-third, to 7.3, in the year 1928.
>
> This is probably not more than one-third to one-fourth of what it was prior to 1890. But this is not all. For even a continuation of the present birth and death rates at each age of life will result in a population having far fewer children and many more elderly people and, as a consequence, a rate of increase of less than one-third the 1920 rate.
>
> Furthermore, it is as certain as anything can be that the present birth rates are going to decline still further in the near future. The best evidence of that decline is found in the fact that the 1928 birth rates for certain sections of the population are much below those for the entire country. Already the white population of our large cities, and indeed of some of the more highly urbanized states in the Northeast, has birth rates too low to maintain its present numbers over any considerable period of time. Thus if the 1928 birth rates and death rates at each age of life prevail in the future and no additions are made, except through births from within the group, the white population of Connecticut, Massachusetts and New York will have more deaths than births, and will decrease 31 per cent in a century. On the same basis, the whites in New York, Philadelphia, Detroit, and eight other of our larger cities will decline 40 per cent.
>
> • • • Our estimates show that the rate of increase will be only two-thirds to three-fourths as great in the decade 1930-40 as in the decade just ending; and that the absolute growth will be little if any greater than it was in the decade 1880-1900. With this great decline in population growth and with a plant capacity already well in excess of our demands, it requires no prophet to foresee that our business men are soon going to face some formidable problems in adjusting our economic organization to the new situation. Will they be able to make these readjustments so easily and quickly that our prosperity will not lapse?
>
> • • • The balance between old and young to which we are accustomed will thus be entirely upset, for instead of having twenty-five persons under twenty years of age for each ten persons over fifty, the ratio will drop to twelve to ten, less than half as many.†

Recent investigations of the population problem have revealed the necessity of refinement of method in the use of birth rates. Differences in age and sex distribution within a population bring about differences

* Kuczynski, R. R. The Balance of Births and Deaths. Page 9. The Macmillan Company, 1928.

† Thompson, W. S., and P. K. Whelpton. A Nation of Killers in the Making. The American Mercury. Pages 385-391. April, 1930.

in crude birth rates, even though the births per one thousand women of childbearing age remains the same. The crude birth rate is the number of children born expressed as a percentage of the entire population. It is an inadequate means of measuring natural increase in a population having a shifting composition either because of declining birth rates or immigration.

There has been some speculation as to what extent the present sharp decline in birth rate indicates a permanent change in fecundity of the population and to what extent it represents a temporary change, later to resume a less precipitous but still a definite downward trend. At the annual meeting of the British Medical Association held at Cardiff in 1928 the falling birth rate was one of the central points of discussion. Professional men and women from the fields of medicine and economics debated the problem from various points of view. In summarizing the conclusions of this meeting the editor of the *British Medical Journal* made the following statement concerning the birth rate:

> There is a law of population growth which occurs in cycles, following in the main a curve of a definite type. The birth rate is falling now because we are at the end of such a cycle, and it will not again rise until those factors which are at present over-riding the inherent tendency to increase are recognized and removed. Density is one of the controlling factors, but the estimate of density should be applied not only to a country, but to restricted localities, and must be judged, not by total numbers, but by the relation of such numbers to resource and opportunity. Voluntary control of conception has undoubtedly prevented the birth of many individual babies, but it may be doubted whether this has appreciably affected the crude birth rate or population growth cycle.*

This statement somewhat ameliorates the concern of those who see in the present decline a sudden cessation in population growth. That birth rates of California follow cyclical tendencies is emphasized by Figure 1 in Plate IV. Although California vital statistics have not been recorded in detail for a sufficiently long period to show complete cycles or to make possible adequate comparisons with the census, it is possible, by making approximations of the numbers in different age groups of the population between 1920 and 1930, to estimate approximately the number of children born per thousand women of childbearing age. While a high degree of accuracy is not claimed for the estimate thus made, the general trend in birth rate can be shown. The numbers of children per thousand women in the age groups 15 to 44 rose from less than 60 in 1910 to more than 85 in 1924 and has since then been declining rapidly. This trend in birth rate, it must be understood, reflects not only changes in the birth rate for each specific age group, but is in a large measure a reflection of the shifts in age distribution within that portion of the represented population. Even when birth rates are studied on the basis of five- or ten-year age groups, variations in age distribution within those groups distort the birth rate and many wrong conclusions can easily be drawn in regard to its trend. More will be said of this trend in birth rate in relation to forecasts of United States and California population.

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* Editorial, The Falling Birth Rate. The British Medical Journal. Page 499. Sept. 15, 1928.

Plate IV

NUMBER OF BIRTHS PER 1000 WOMEN BETWEEN THE AGES OF 15 AND 44 IN THE CALIFORNIA POPULATION

NUMBER OF DEATHS IN CALIFORNIA COMPARED TO POPULATION

Mortality Rates.

Specific mortality rates do not give so much trouble as birth rates in estimating future population. Improvement in the death rate of children, however, has an important effect in preventing a greater decline than would have otherwise taken place in the ratio of children to total population resulting from declining birth rates. Crude mortality rates on the other hand show variation, due not alone to changes in death rates in each specific age group, but, like birth rates, also to material shifts in the age composition of the population. Not only does age composition of the population have an important effect upon mortality rate, but the ratio of foreign to native elements in the population also has an important influence. In Figure 2, Plate IV, are shown the numbers of deaths in California from 1906 to 1929, inclusive. In the same figure the trend in the population is shown.* In this figure careful observation will show that the two trends are farther apart in the later years than in the early period, indicating an improvement in the crude rate of mortality. To what extent the improvement shown for the past decade may have been due to a more complete census in 1930 can not be easily determined. We are not confronted, however, with the erratic variation observed with respect to birth rate.

Net Reproduction Rate.

Crude rates of natural increase, computed on the basis of differences between births and deaths and expressed as a percentage of the total population, are subject to the same errors involved in treating births and deaths separately in such a manner.† It became very important to consider the age composition of the female population in any long-period prediction of population growth. After applying such a detailed

* Inasmuch as this graph is on a semi-logarithmic scale, if the trend in deaths were exactly parallel to the trend in population it would indicate an unchanging crude mortality rate; that is, the ratio of the total number of deaths to the total population would remain the same.

† A way out of the difficulty is proposed by Kuczynski as follows:

"It became necessary, first, to ascertain on the basis of present mortality how many out of 1000 newly born girls reach childbearing age, that is, fifteen years, how many reach sixteen, etc., and finally how many pass through childbearing age, that is, reach fifty years. This information is to be derived from the life table which for a given period exhibits the number of females surviving at the beginning of each year of age out of 1000 live-born, assuming that the mortality for each year of age was that of the period under consideration.

"It becomes necessary, secondly, to ascertain the actual number of females living in each year of childbearing age and the number of female births by years of age of the mother in order to compute the female fertility rate for each year of age, *i. e.*, the number of female births for 1000 women fifteen to sixteen years, or 1000 women sixteen to seventeen years, etc.

"It became necessary, thirdly, to apply those fertility rates to the number of women who according to the life table would in a stationary population be fifteen to sixteen years of age, sixteen to seventeen years, etc. These numbers are derived from the number of female survivors by assuming that the women fifteen to sixteen years would be equal to the average of those surviving fifteen and those surviving sixteen years, etc. By multiplying the number of women of fifteen and sixteen years in the stationary population by the female fertility rate of the women of fifteen and sixteen years, we find how many girls will be born to 1000 newly born girls at the age of fifteen to sixteen years (with present natality and mortality). By a similar computation we find the results for the age sixteen to seventeen, etc. The sum of all the new fertility rates thus found will show the total number of females borne by the original stock of 1000 females. If this total is equal to 1000, the population holds its own; if it is larger, the population increases; if it is smaller, the population, in case natality and mortality continue the same, is bound to die out.

"This is the only accurate method of calculating a fertility table. The basic data needed for its computation are a life table for females, the actual number of women for each year of childbearing age, and the number of female live-born by years of age of the mothers."

Kuczynski, R. R., The Balance of Births and Deaths. Pages 42–44. The Macmillan Company, 1928.

analysis to the populations of Europe Knezynski concludes that in "Western and Northern Europe in 1926, 100 mothers gave birth to 93 future mothers only. With the fertility of 1926, the population is bound to die out unless mortality of potential mothers decreases beyond reasonable expectations. And fertility continued its downward path in 1927."*

How meaningless different estimates of natural increase for California have been can only be appreciated by a consideration of immigration. In a discussion of balance of births and deaths in the registration area of the United States the statement has been made that the "greatest excess of births over deaths—18.3 per 1000 population—appears for Utah, and the lowest—3.1 per 1000 population—appears for California."† This figure representing California's natural increase has been subjected to much misinterpretation. It will be shown in a later paragraph how immigration, if it does not actually make estimates of natural increase impossible, so obscures the fundamental elements necessary for its calculation and use that the prediction of California population necessarily must deviate in method from the use of devices developed in recent investigations, which are so important with respect to the national population problem.

Immigration.

Immigration into a country or into a state is influenced by economic conditions in the state or country from whence the immigration came as well as within the area receiving the immigrants. In studies of immigration into a country like the United States it is possible to make use of the national immigration statistics. In a state like California, where immigration is such an important factor in population, it becomes necessary to resort to a different method of estimating immigration. The details of the method used in the present investigation will be described in a later section. At this point, however, it might be well to indicate how differently the immigration problem must be approached when the analysis is made for a state or section of the country than when the entire population of the nation is under consideration. For a state there are no immigration statistics. Net immigration can not be computed, therefore, on the basis of differences between annual immigration and emigration. Figures have already been given which show the importance of immigration in California population growth. An index of immigration from other states and foreign countries is essential. Such an index can be constructed from population figures and available mortality tables.

Application of the Foregoing to a Long-Time Population Forecast.

Many different methods have been used to forecast population. During the period from one census to the next indexes such as school enrollment have been used. All such indexes, however, take the forecast up to the current year only. Forecasts have been made, however, by projection of straight lines into the future, starting with past trends plotted on cross section or semi-logarithmic paper. For short periods such esti-

* *Ibid.* Page 31.

† Rogers, S. L., Birth Statistics, Fifth Annual Report, 1918. Page 8. U. S. Dept. Commerce, U. S. Govt. Printing Office, 1921.

mates may have their application. Some refinements have been made in this kind of projection by the use of various mathematical curves. For a period of four decades, however, which seems the minimum for such an investigation, fundamental changes taking place in the composition of the population make necessary a consideration of the factors discussed briefly in the foregoing pages. A brief statement of how these principles have been applied by the Scripps Foundation of Miami University in estimating future population of the United States follows.

A FORECAST OF UNITED STATES POPULATION

Whelpton,* in estimating the future population of the United States, computed specific birth rates by a method which corresponds very closely to the proposal of Kuczynski except that instead of making his calculations for each year of age his rates apply to women in five-year age groups from 15 to 49 years of age. His observations of birth rate for specific ages of mothers over the past 20 years indicate decreases per decade as follows:

	Urban	*Rural*
Native white	4.2 per cent	5.4 per cent
Foreign white	5.0 per cent	6.6 per cent
Negroes	3.8 per cent	6.2 per cent

Looking into the future, average percentage declines per decade for the next 45 years are indicated for the same groups as follows:

	Urban	*Rural*
Native white	3.5 per cent	4.5 per cent
Foreign white	5.6 per cent	6.4 per cent
Negroes	5.0 per cent	6.8 per cent

These percentages have been computed by using the specific birth rates computed by Whelpton.†

It will be observed that percentage decline in birth rate is not given for different age groups. This is because for a given nativity class, either urban or rural, the percentage is the same regardless of age. This would indicate that in determining the trend in birth rates it was probably impossible to obtain the necessary data to take this further step in the calculation of specific birth rate. This is an important point with respect to interpretation of the adequacy of the birth rates employed by Whelpton, which are considered even by himself as being too high. On the basis of specific birth rates, trends in survival rates, modified by experience in low-death-rate countries, and estimates of immigration all applied to 1920 population, which he previously had corrected for underenumeration, he estimates future United States population as follows:

Year	*Estimated population*
1940	138,250,000
1950	151,620,000
1960	162,670,000
1970	171,460,000
1975	175,120,000

While this estimate appears somewhat low to the more optimistic, it checks fairly closely with widely quoted estimates made by Raymond

* Whelpton, P. K., Population of the United States, 1925 to 1975. The American Journal of Sociology. Vol. XXXIV. Pages 253–270. Sept., 1928.
† *Ibid.* Table IV, page 262.

Pearl.* Although Pearl's method of estimate has been severely criticized because of his claim to a law of population growth based upon biological principles of growth of lower forms of life, his mathematical curves fit a number of different populations. Whether or not the two methods of forecast can be reconciled, that of Whelpton seems to rest upon principles which are more easily explained and understood and are more nearly in accord with the methods developed by Kuczynski and other recent investigators. That Whelpton's estimate is not claimed by himself to be the last word in United States forecast, however, is indicated by his own statement that although "these estimates were published only about two years ago, we would probably obtain somewhat lower figures as to future population and birth rates if we were calculating them today. The decline in the birth rate since 1926 has continued at a more rapid rate than we anticipated when our computations were made. We do not have enough information to hazard any estimate of how much lower revised calculations would be, but we feel safe in saying that our population figures are quite optimistic."†

School enrollment statistics show a very sharp decline in the numbers of younger pupils, and calculated birth rates which purport to be specific birth rates by given age groups have given rise to much discussion about an early date at which the United States will have a stationary population. Recent statements made by well known writers indicate such a situation is possible with regard to our United States population as early as 1975. Attention already has been called, however, to the results of debate in England upon the question of the falling birth rate. In view of the fact that future land requirements for the California fruit industry and immigration to California have been based upon the above estimates of United States population, a further comment may well be made with regard to the present low birth rate in the United States. It has been stated that births are observed in relation to groups of the population in which there is a considerable range in ages and that a pronounced change in age distribution in this group will materially affect the number of births per 1000 persons in it. Specific birth rates are as important in observing trends over a period of years as in carrying out detailed calculations in the various steps of a forecast. Unless the age groups are very small, changes in age distribution will have an important effect in the trend of the birth rate. Births per 1000 women of childbearing age, on the other hand, can be very greatly influenced by a change in the proportion of that number who are between the ages of 25 and 35.

There are important fluctuations in the numbers in the different age groups in the population. The effects of panics and wars reverberate through the generations, alternately showing up in the numbers of children and in the numbers of mothers. A considerable percentage of the children of the United States to be born between 1935 and 1940 will be granddaughters and grandsons of the large numbers of children under 10 years old in 1885, who were augmented in numbers by a heavy immigration between 1900 and 1910. These children will be sons and daughters of a resulting large group of future mothers born between

* Pearl, Raymond, The Biology of Population Growth, 260 pages. Copyright 1925, by Alfred A. Knopf, Inc.

† Personal letter under date of June 27, 1936, from P. K. Whelpton.

1905 and 1915. The great-grandmothers of the 1940 babies were born in the United States or foreign countries before the Civil War. Their husbands were too young to be materially reduced in numbers by the Civil War. The grandmothers participated in the western land settlement movement in the eighties. Their fathers were born between 1900 and 1910 and were too young to participate in the World War. Born under a lucky star, this series of generations is destined to play an important part in shaping the economic structure of our near future. To be sure, each mother will not have so many children as her mother and grandmother, but during the next decade there will be a larger number and larger percentage of mothers in the ages of maximum fecundity.

In sharp contrast, the relatively few baby girls of the Civil War period came to the age of maximum fecundity when the economic situation in the United States was in the doldrums. Although their numbers were augmented by immigration, many of their children, born in the nineties, fought the World War and many of them died from influenza. Their surviving daughters have just passed the maximum childbearing age. The small number of their offspring may be something to take into consideration when levying bond issues to be paid by the income from dairy farms during the period 1955 to 1965, at which time the country probably will again have a shortage of young milk drinkers. This applies to the United States as a whole. California population for some reason follows tendencies opposite to those of the United States in regard to the ratio of numbers of children to numbers of women of childbearing age, except that the trend has been downward in each case. The situation in the United States may have importance, however, relative to shipments of low-priced products into California from other states.

Variations in the composition of the population seems to promise much by way of explaining many of our economic phenomena which have heretofore defied explanation. It would certainly be far beyond the fondest hopes of economists to forecast depressions 30 years in advance and this may never be possible. How important changes in age distribution in the population may be in relation to the business cycle can only be determined by much study. This relation established, however, the age distribution of the population can be predicted many years in advance. In any event we may expect, because of the variations described, important changes in our birth rate. Proof of this is the purpose of the present digression.

The foregoing brief statement of certain of the important influences operating with respect to population in general have a distinct bearing upon the question of California land requirements. The rate of growth of our fruit acreage will be dependent upon United States population growth. Our own population growth will be affected in time by a diminished source of supply of immigrants, and our natural increase will be influenced by the age and nativity of those coming to live amongst us.

CHAPTER III

AN ESTIMATE OF FUTURE CALIFORNIA POPULATION

Future California population increase will depend upon a continuation of a source of immigration, trends in birth and death rates, and upon the extent to which California resources and policies will continue to make possible a comfortable living for those who come and for those now here. The method by which these have been estimated has consisted of a determination for each of the next four decades, of net effective immigration of persons 10 years of age and over; the numbers of those in the state at the beginning of each decade surviving to the end of the decade, and finally the numbers of children under 10 years of age, whether they have come in as immigrants or by birth. This has been done from the standpoint of trends in population growth itself, the results thus obtained then having been analyzed with special reference to California land and water resources. The previous chapter has been primarily an analysis of the prospects for a continuing source of immigration. We are now interested in observing the effects of these broader influences upon California population growth.

The Sources of California Population.

The records of the United States Census contain the nativity of population in considerable detail. From these records it appears that in 1920 the California population included 1,268,243, or 37 per cent, who were born in California, 1,400,993, or 41 per cent, who were born in other states, and 757,625, or 22 per cent, who were born in foreign countries. By combining the percentage coming from other states with that of foreign-born immigrants it will be seen that in 1920 California was populated to the extent of 63 per cent by persons of immigrant origin. It appears likely that the final results of the 1930 census enumeration will reveal an even greater portion of our total population of native or foreign immigrant origin.

In the decade 1900 to 1910 more than half of the native white immigrants to California were born in eight states, most of which were middle western states, including Illinois, Iowa, Kansas, Missouri and Ohio. In that decade California immigration included more than 35,000 native white persons born in Texas, and New York and Pennsylvania each contributed nearly an equal number. In the decade 1910 to 1920 these same eight states were the largest contributors to California population, although the total immigration coming from this group was somewhat less than it had been in the previous decade. Where these immigrants had lived between the time of their birth and the time of their arrival is not shown in the census statistics, from which, together with the use of mortality tables, they were derived. An outstanding characteristic of the entire migratory movement within the United States during the past two decades has been the movement toward California. A study of the migratory movement from almost any state in the entire country will reveal California as the destination

of an important part of the emigrants and where shifts have appeared in the migratory streams from the various states they usually have shown a balance in the direction of California.

That it is possible for a state to have its stream of immigration suddenly reduced may be well illustrated in the case of the state of Washington. In the decade 1900 to 1910 more than three times as many people took up their home in that state as in the following decade between 1910 and 1920. This is something to consider in the interpretation of the estimates which follow concerning the future immigration into California. The important observation to be made, however, is that the numbers of people entering into the migratory movement in the United States as a whole has exceeded 5,000,000 persons for the two decades under consideration. Indications are that in the past decade, 1920 to 1930, more people were on the move than in either of the two previous decades. California's share in this stream of migration will be dependent to a great extent upon the opportunities which she can continue to offer.

Table 1 and Plate V present the historical picture of the nativity composition of California population at each census enumeration, 1870 to 1920, with an estimate of the nativity composition in 1930 based upon preliminary census returns indicating approximately 5,650,000 for the state total. All signs point to an increase in the rate of growth of the California-born portion of the population during the last decade. In the face of this, the immigrant portion appears to have soared to greater heights. The rate of immigration is increasing so rapidly that despite an apparent increasing rate of growth in the indigenous population it is forced into an ever smaller proportional place in the total. Measured in terms of absolute quantity or by relative standards, immigration to California has been, up to the present, truly a rising tide.

Net Effective Immigration.

In order to avoid confusion with the term ordinarily used to indicate the difference between numbers of persons immigrating and those emigrating the descriptive phrase *net effective immigration* is used. Its purpose is to designate the number of persons who have come into the state and have survived and remained to the end of the decade, in excess of those of the California population who have moved away. This index of immigration not only makes use of available statistics to advantage, but, as the phrase indicates, truly represents that part of the immigrant population which is effective in increasing its numbers. It has been computed by five-year age groups of male and female, and of foreign and native, for four decades, 1880 to 1920, inclusive. In addition, estimates have been made for the decade 1920 to 1930 with no attempt to make separate estimates for the native and foreign portions of the population. On the basis of the estimates for these five decades net effective immigration has been computed without segregation into age groups for the two decades 1860 to 1870 and 1870

TABLE 1

NATIVITY COMPOSITION OF CALIFORNIA POPULATION

Year	Total population	California born	Foreign and native immigrant	Native immigrant
1850	92,597			
1860	379,994			
1870	560,247	191,067	188,124	188,220
1880	864,694	320,040	518,654	245,820
1890	1,208,130	475,843	732,287	464,478
1900	1,485,053	661,280	823,773	476,444
1910	2,377,549	980,000	1,473,353	897,121
1920	3,426,861	1,968,243	2,158,618	1,460,961
1930	5,970,000	3,791,600	3,852,400	

[1] Estimated

to 1880.* Table 2 summarizes the estimates of total net effective immigration into California by ten-year age groups from 1880 to 1930, inclusive. The same data converted to percentage of the total immigration 10 years of age and over are shown in Table 3.

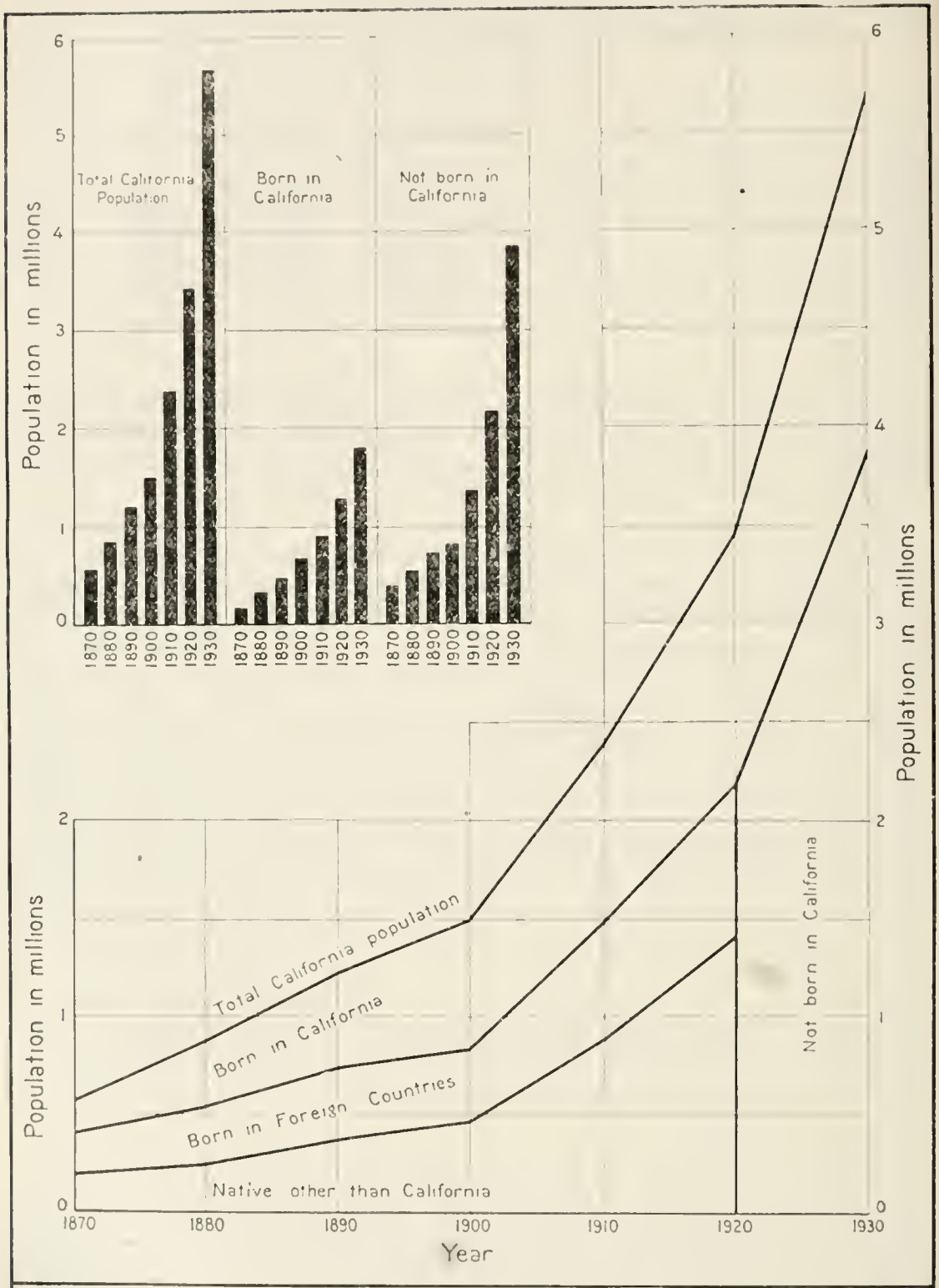
Plate VI, which is based upon Tables 2 and 3, presents net effective immigration each decade from 1880 to 1930, segregated into ten-year age groups. The most striking fact brought out by this plate is in the age composition of this net effective immigration. More than 68 per cent of the immigrants in each decade have been under 40 years of age. The average age of immigrants during the decade 1880 to 1890 was 26 years, in the next decade increasing to 27 years. The decade 1900 to 1910 witnessed the largest proportional shift to the older age groups and raised the average to 32 years. In both of the past two decades the average age of immigrants has been 31 years. This is a reflection of the changes in composition of the national population. Despite this tendency of the average age to rise, due to the numbers of older persons having a larger percentage in the distribution of total net effective immigration, the younger groups continue to comprise the numerical and proportional supremacy. This is a demonstration of what has already been stated. California is not being populated through the immigration of the advanced in age, those past the prime of life who come here to spend their declining years in a friendly climate. These come too in an increasing stream, but they have been, and probably will continue to be, a minor part of the total.

Trend in the Sex Ratio.

The ratio of men to women in the immigration stream has been a constantly shifting figure. For this reason it is necessary to give some attention to the sex ratio in the California population when estimating

* The general plan of estimate has been to subtract from the census population of a given age, sex and nativity group at the end of a decade, the survivors of the population of the same group ten years younger at the beginning of the decade. For all ages 10 years and over the difference necessarily must have been the result of immigration and emigration. The survivors at the end of a decade of the group who were in California at the beginning of the decade have been estimated by the use of life tables prepared by the United States Department of Commerce. It has been necessary in the early decades to use United States life tables. For 1850, however, there is available an abridged California life table which has been used. There is some variation between California and United States mortality rates, but estimates of error caused by the differences between these tables have shown that the small differences in survival rates have very little effect upon the final results obtained. Detailed estimates of net effective immigration by five-year age groups, with explanations as to each step in their calculation, are given in Tables 1A to 9A, inclusive, in Appendix A.

Plate V



CALIFORNIA POPULATION TRENDS

SHOWING PROPORTIONS WHICH ARE CALIFORNIA, NATIVE OTHER THAN CALIFORNIA AND FOREIGN BORN.

TABLE 2

TOTAL NET EFFECTIVE IMMIGRATION INTO CALIFORNIA, 1880-1930

Age group	1880 to 1890	1890 to 1900	1900 to 1910	1910 to 1920	1920 to 1930
10-19	51,857	56,086	123,745	183,087	241,860
20-29	82,208	59,387	208,748	227,645	480,694
30-39	45,084	26,891	175,874	165,772	340,567
40-49	14,411	7,819	92,868	105,682	202,207
50-59	1,932	[1,059]	40,282	60,124	148,980
60-69	3,146	11,241	24,405	[20,000]	48,223
70-79	1,020	741	6,672	21,013	25,110
80-89	1,661	1,284	3,366	6,445	10,862
90+	281	258	502	764	14,079
Totals	217,400	190,870	718,822	780,411	1,717,738

[1] For method of computation see Tables IA, 6A, Appendix A.
[2] Figures in boldface represent net immigration for the decade.

TABLE 3

PERCENTAGE AGE DISTRIBUTION OF TOTAL NET EFFECTIVE IMMIGRATION INTO CALIFORNIA, 1880-1930

Age group	1880 to 1890	1890 to 1900	1900 to 1910	1910 to 1920	1920 to 1930
10-19	23 85	31 88	17 08	19 19	13 75
20-29	37 47	31 08	28 25	28 02	27 66
30-39	21 11	17 17	24 47	20 81	28 05
40-49	6 65	4 04	12 86	13 21	14 92
50-59	0 47	[1 68]	5 62	8 19	[6 05]
60-69	4 23	2 17	4 86	6 53	2 64
70-79	0 49	0 47	1 74	2 72	1 48
80-89	0 47	0 80	0 46	0 81	62
90+	0 18	0 17	0 08	0 09	84
Totals	100 00	100 00	100 00	100 00	100 00

[1] 100 percent minus 93. See Table 2.
[2] Figures in boldface represent net immigration for the decade.

the numbers of children. Tables 4 and 5 give estimates of net effective immigration and the percentage distribution of immigration by ten-year age groups segregated according to sex. It will be noticed that in the later decades the immigration of women more nearly equals that of men. In the early decades, however, the percentages of men between the ages of 20 and 39 were much greater than those of the women. Throughout the entire period of observation the percentage of women in the older age groups has exceeded that of the men, and in the decade 1890 to 1900, when there was an actual exodus of native-born men in the age groups between 30 and 65, there was still a net balance of immigration by women. This increasing ratio of women to men has to a certain extent offset some of the negative influences which are reducing the numbers of children in proportion to the total population.

Ratio of Foreign Immigration to Native.

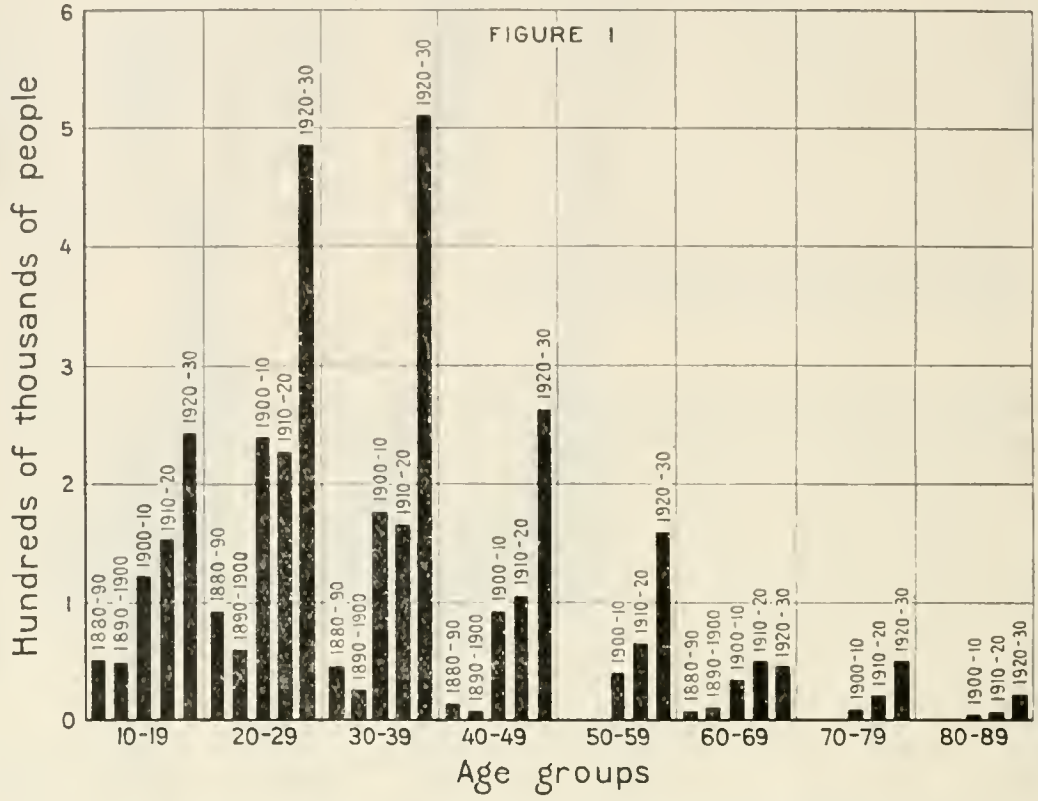
An influence which has considerable importance, not only with respect to estimating the numbers of children in the population, but also with respect to estimating future trend in mortality rates, is the trend in the ratio of the numbers of foreign persons to native among those immigrating to California. Net effective immigration has therefore been segregated by age groups and according to nativity. These estimates are presented in Tables 6 and 7, the latter giving the percentage

Plate VI

NET EFFECTIVE IMMIGRATION INTO CALIFORNIA DURING THE PAST FIVE DECADES BY TEN YEAR AGE GROUPS

(AGES UNDER TEN NOT INCLUDED)

FIGURE 1



PERCENTAGE AGE DISTRIBUTION OF NET EFFECTIVE IMMIGRATION INTO CALIFORNIA 1880-1930

(NET EFFECTIVE IMMIGRATION TEN YEARS OF AGE AND OVER = 100 PER CENT)

FIGURE 2

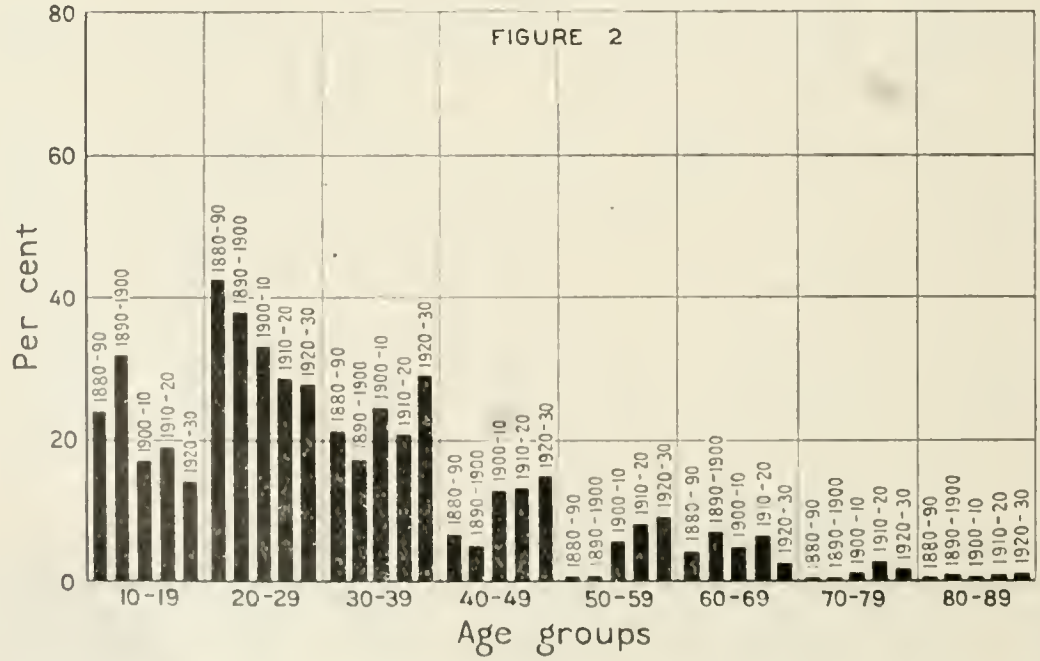


TABLE 4

NET EFFECTIVE IMMIGRATION INTO CALIFORNIA, SEGREGATED ACCORDING TO SEX, 1880-1930[1]

Age group	1880 to 1890	1890 to 1900	1900 to 1910	1910 to 1920	1920 to 1930
Male					
10-19	27,423	25,402	65,719	78,688	136,648
20-29	68,141	34,344	151,[illegible]	116,024	285,499
30-39	11,386	15,[illegible]	114,544	78,573	295,935
40-49	6,342	292	58,897	51,094	152,562
50-59	[2]2,601	[2]5,043	29,702	20,355	83,069
60-69	5,125	6,[illegible]	20,105	24,104	11,404
70-79	470	996	3,921	9,544	8,106
80-89	488	449	1,436	2,855	4,216
90+	182	184	360	291	6,973
Male totals	121,140	77,407	453,[illegible]	390,328	984,442
Female					
10-19	24,384	24,607	57,026	73,[illegible]	105,157
20-29	29,727	25,599	87,047	111,621	200,555
30-39	14,[illegible]84	11,125	61,310	87,202	214,632
40-49	8,074	7,418	36,768	53,[illegible]58	109,745
50-59	3,924	3,[illegible]84	20,282	35,[illegible]90	75,890
60-69	3,821	4,272	14,363	26,256	34,921
70-79	1,529	1,737	5,756	12,071	18,004
80-89	564	755	1,870	3,504	6,686
90+	140	141	262	443	7,706
Female totals	86,320	79,468	284,684	404,883	773,296
Grand totals	217,460	156,875	718,622	795,411	1,757,738

[1] For method of calculation see Tables 1A to 6A, Appendix A.
[2] Figures in boldface represent net decrease for the decade.

TABLE 5

PERCENTAGE AGE DISTRIBUTION OF NET EFFECTIVE IMMIGRATION INTO CALIFORNIA, SEGREGATED ACCORDING TO SEX, 1880-1930

Age group	1880 to 1890	1890 to 1900	1900 to 1910	1910 to 1920	1920 to 1930
Male					
10-19	20 91	32 82	15 14	20 15	13 88
20-29	48 15	44 37	34 [illegible]	29 71	29 00
30-39	22 [illegible]	20 42	26 40	20 12	30 06
40-49	4 84	0 38	13 58	13 08	15 50
50-59	[1] 98	[1] 6 51	4 68	7 [illegible]	8 44
60-69	4 [illegible]	9 00	4 [illegible]	6 17	1 16
70-79	0 36	1 29	0 90	2 44	0 82
80-89	0 [illegible]	0 [illegible]	0 [illegible]	0 74	0 43
90+	[illegible] 19	0 17	0 07	0 07	0 71
Totals	100 00	[2]100 00	100 00	100 00	100 00
Female					
10-19	28 25	30 [illegible]	20 [illegible]	18 27	13 60
20-29	33 [illegible]	32 [illegible]	[illegible] [illegible]	27 57	25 94
30-39	17 [illegible]	14 [illegible]	21 54	21 54	27 75
40-49	9 [illegible]	9 [illegible]	12 [illegible]	13 [illegible]	14 19
50-59	4 [illegible]	[illegible] [illegible]	7 12	8 [illegible]	9 81
60-69	4 [illegible]	[illegible] [illegible]	[illegible] [illegible]	6 48	4 52
70-79	1 77	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]
80-89	[illegible] [illegible]	0 [illegible]	0 [illegible]	0 87	0 [illegible]
90+	[illegible] 17	0 [illegible]	0 [illegible]	0 11	1 00
Totals	[3]100 00	100 00	100 00	100 00	100 00

[1] Figures in boldface represent net decrease for decade.
[2] 100 per cent=86,320. See Table 4.
[3] 100 per cent=77,460. See Table 4.

TABLE 6

NET EFFECTIVE IMMIGRATION INTO CALIFORNIA, SEGREGATED ACCORDING TO NATIVITY, 1880-1920[1]

Age group	1880 to 1890	1890 to 1900	1900 to 1910	1910 to 1920
Native				
10-19	37,124	37,445	88,300	117,048
20-29	43,423	21,136	121,083	136,904
30-39	18,524	[2]**6,957**	89,235	100,971
40-49	7,309	**12,802**	55,161	74,154
50-59	878	**8,792**	29,948	48,351
60-69	3,963	1,645	21,662	35,166
70-79	628	**294**	7,155	15,586
80-89	598	673	1,795	4,125
90+	182	157	209	336
Native totals	112,629	32,211	414,548	532,641
Foreign				
10-19	14,683	12,564	34,442	35,609
20-29	48,945	38,447	117,660	90,741
30-39	27,810	33,888	86,639	64,804
40-49	7,107	20,712	37,504	30,898
50-59	145	7,733	10,637	16,773
60-69	5,183	9,596	12,806	15,194
70-79	431	1,035	2,522	6,029
80-89	434	581	1,511	2,324
90+	99	108	353	398
Foreign totals	104,837	124,664	304,074	262,770
Grand totals	217,466	156,875	718,622	795,411

[1] For method of calculation see Tables 1A to 9A, Appendix A.
[2] Figures in boldface represent net decrease for the decade.

TABLE 7

PERCENTAGE AGE DISTRIBUTION OF NET EFFECTIVE IMMIGRATION INTO CALIFORNIA, SEGREGATED ACCORDING TO NATIVITY, 1880-1920

Age group	1880 to 1890	1890 to 1900	1900 to 1910	1910 to 1920
Native				
10-19	32.96	116.24	21.30	21.98
20-29	38.55	65.62	29.20	25.70
30-39	16.45	[1]**21.60**	21.53	18.96
40-49	6.49	**39.74**	13.31	13.92
50-59	0.78	**27.30**	7.22	9.08
60-69	3.52	5.11	5.23	6.60
70-79	0.56	**0.91**	1.73	2.93
80-89	2.53	2.09	0.43	0.77
90+	0.16	0.49	0.05	0.06
Native totals	100.00	[2]100.00	100.00	100.00
Foreign				
10-19	14.01	10.08	11.33	13.55
20-29	46.69	30.84	38.69	34.55
30-39	26.53	27.18	28.49	24.66
40-49	6.78	16.61	12.33	11.76
50-59	0.14	6.20	3.50	6.38
60-69	4.94	7.70	4.21	5.78
70-79	0.41	0.83	0.83	2.29
80-89	0.41	0.47	.50	.88
90+	0.09	0.09	.12	.15
Foreign totals	100.00	100.00	100.00	100.00

[1] Figures in boldface represent net decrease for the decade.
[2] 100 per cent=32,211. See Table 6.

distribution of the actual numbers shown in the former. The immigration of native-born includes many more under the ages of 20 than does the foreign-born. The striking feature of these tables, however, is the fact that in the decade 1890 to 1900, when native-born people were actually leaving California, the foreign born continued to come in considerable numbers.

From 1860 to 1920 the percentage of native-born, *i. e.*, born in the United States, in the total California population increased from slightly more than 60 per cent to nearly 80 per cent. During the same period the percentage of native-born in the immigrant population increased even more rapidly. With the exception of the decade 1890 to 1900 the ratio of native to foreign in the net effective immigration had a corresponding increase. All of these shifts have had a resultant effect in mortality rates and in the trend of age distribution.

Ratio of Urban Population to Rural.

From 1900 to 1920 the percentage of the California population which is urban increased from 52.4 per cent to 68 per cent. It is a well known fact that the number of rural persons in a population greatly affects its rate of growth because of the higher birth rate in the rural areas. There are many towns in California having less than 2500 inhabitants which would come under the census classification of rural but which are more urban in their characteristics than rural. We are therefore without adequate basis for observing trends of the ratio of farm population to total. There are indirect methods of approximating this trend, but because the rapid development of highway and automobile transportation has so greatly changed the nature of the rural population, which would necessarily form an important part of such an estimate, such a procedure would be of questionable value as applied to the present problem.

The urban character of the entire California population has been pointed to as one of the causes of low birth rate, and it may have had an important influence. Immigration, however, has undoubtedly been of far greater importance in this respect. With our present knowledge of the trends in the rural-urban ratio it seems probably the best way of treating it in our analysis of population growth to make no attempt to separate the effect of changes in the rural-urban ratio from those due to other causes.

Relation of United States Population Increase and Net Effective Immigration Into California.

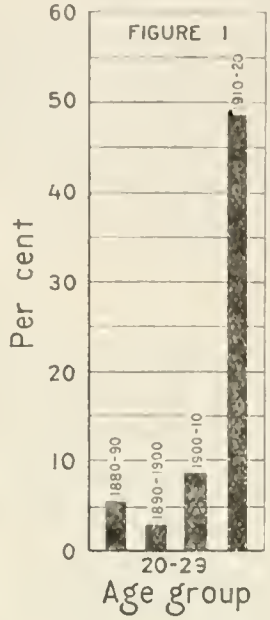
Nearly half of the increase in the number of males between the ages of 20 and 30 in the United States population between 1910 and 1920 came to California. Striking as this fact is the truly significant point is the reason for this high percentage. It is high, not because the number of males immigrating to California departed sharply upward from the trend, but because the increase in the population of the United States as a whole was small.

Immigration to California Continued Along Its Established Trend Despite a Shortage in United States Increase.

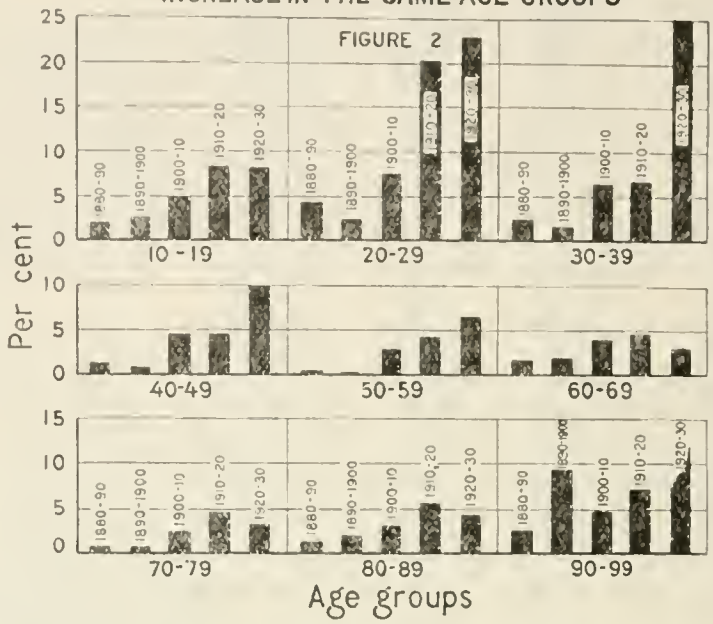
Figures 1 and 2 of Plate VII illustrate the phenomenal increase in the ratio of California immigration to United States population

Plate VII

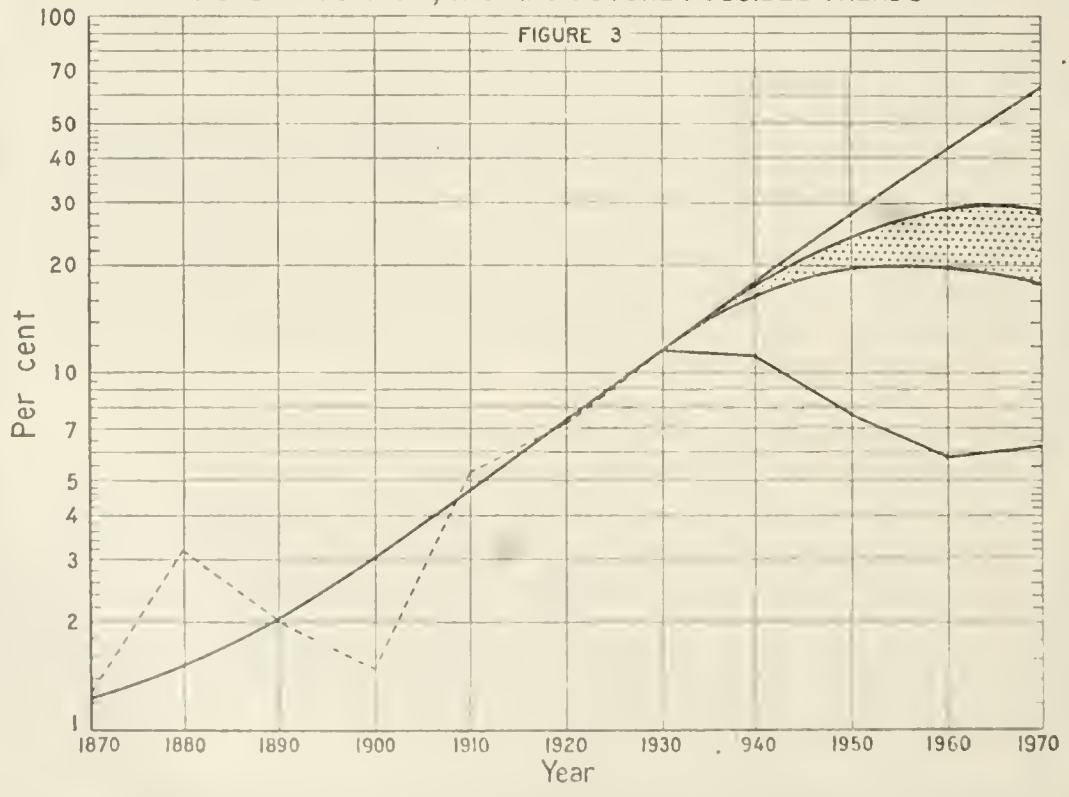
MALE IMMIGRATION TO CALIFORNIA AS A PER CENT OF UNITED STATES INCREASE



NET EFFECTIVE IMMIGRATION TO CALIFORNIA BY 10 YEAR AGE GROUPS EACH SHOWN AS A PER CENT OF UNITED STATES POPULATION INCREASE IN THE SAME AGE GROUPS



NET EFFECTIVE IMMIGRATION TO CALIFORNIA ALL AGES 10 AND OVER AS A PER CENT OF UNITED STATES POPULATION INCREASE AGES 10 AND OVER, SHOWING FUTURE POSSIBLE TRENDS



increase. Figure 1 shows how one particular age and sex group responded to a decline in the rate of increase of United States population.* Figure 2 and Table 8 indicate the upward trend of all of the age groups, male and female combined, in relation to United States population increase for the same groups.† Although ultimately a falling off in United States population is certain to show up in decreased California immigration, as yet it has not decreased the volume of immigration to California in the age groups affected. The numerical size of this immigration continues. Its percentage relation to United States population increase rises as the decline in the rate of increase of United States population becomes more pronounced. United States population increase therefore can only show the approximate limits of net effective immigration in the future. The point should not be overlooked that California is absorbing at the present time more than a tenth of the United States population increase. At the same time, to that extent United States population growth is being sustained by California immigration. Thus we may look upon the relationship between California immigration and United States population increase not in the light of either one being entirely dependent upon the other but as two inter-related phenomena. United States population increase is dependent to a certain extent upon California's resources. California immigration is dependent to a certain limited extent upon United States population increase.

It is with the full appreciation of these facts that the percentage which California net effective immigration bears to United States population increase, has been projected into the future. Upon the basis of this estimated future trend and the estimates of future United States population given in a previous section, net effective immigration has been projected, leaving some margin of variation, in Figure 3 of

TABLE 8

NET EFFECTIVE IMMIGRATION INTO CALIFORNIA 10 YEARS OF AGE AND OVER, BY 10-YEAR GROUPS, AS A PER CENT OF UNITED STATES INCREASE IN POPULATION OF EACH GROUP

Age group	1890 to 1900	1900 to 1910	1910 to 1920	1920 to 1930	1930 to 1940
10-19	1.41	2.46	6.04	9.61	7.40
20-29	6.35	7.45	7.51	10.11	12.76
30-39	1.42	1.28	3.11	5.39	11.74
40-49	1.39	.91	1.62	4.47	5.39
50-59	.71	.28	1.66	4.19	6.51
60-69	1.16	1.53	1.07	1.55	2.81
70-79	.66	.58	1.16	1.59	2.50
80-89	1.31	1.81	2.19	2.65	4.23
90+	1.46	11.61	4.78	7.61	0.36
Total	2.64	1.46	3.38	5.58	11.34

(Figures in italics are estimated and interpolated.)

* In 1890 to 1900 the effective immigration of males in the age group 25 to 29 was 3.44 per cent of the United States increase for that group. In the decade 1900 to 1910, the corresponding percentage was 3.71 per cent, in 1910 to 1920, 8.84 per cent, in 1920 to 1930, 15.41 per cent.

† It will be noted that completed immigration of persons having ages 20 to 24 jumped to 20.2 per cent of United States increase in 1910 to 1920. The immigration of the 10 to 19 year age group in 1920 to 1930 made the second highest item, but the 20 to 29 year age group showed in 1910 to 1920. The increase in the 10 to 19 years age group in 1920 to 1930 had come from the 0 to 9 year age group of 1910 to 1920. This shortage in the increase will pass through the entire life span of the United States population as the decades progress.

Plate VII, in which estimates of immigration are shown for each of the next four decades. The *extreme upper limit* is based upon judgment as to how much of the United States increase might possibly be diverted to California over a period of a few decades. The *extreme lower limit* is based upon judgment as to how radical a decline in immigration we might expect and upon the probable future trend of the California fruit industry. Attention has already been called to the sudden curtailment in the immigration to the state of Washington. No such curtailment has been anticipated even in the lowest estimate of future immigration to California. This does not mean that such a curtailment is not possible.

Between these two extremes are given two estimates of immigration which in the light of available information seem to indicate the reasonable limits of variation. The *reasonable lower limit* calls for a further increase in immigration during the current decade of 476,000, while the *reasonable upper limit* calls for an increase of 640,000. Each is smaller than the increase of the past decade.

Table 9 gives the data forming the basis of constructing the trend of net effective immigration, while Table 10 contains the resulting prediction of immigration. The lower estimate anticipates an increase of another half million during the next decade and a slight increase in the next, followed by a decline. Nothing short of a business depression as serious as the one in the nineties is likely to bring about a sudden decline in immigration. Let it be understood, however, that such a condition is possible. In fact, such a depression seems to be in the making at the present time. In the face of the present economic conditions let it be emphasized that no attempt has been made to forecast cyclical variations. The population estimates given here are trend values only; the figures for any given year may be higher or lower than the trend, as economic conditions change.

The Future Survival Rate.

It has been stated that the prediction of California population growth has been carried out in three steps for each of four decades. The first of these was the calculation of probable net effective immigration for ages of 10 years and over. The other two were the determination of numbers of survivors at the end of the decade of those living in California at the beginning of the decade, and finally the calculation of numbers of children.*

Trends in the numbers of California deaths in relation to the rate of California population have already been discussed in connection with Plate IV. It has been observed that the number of deaths increased at about the same rate as the population from 1910 to 1920, but between 1920 and 1930 there was an apparent improvement in the mortality

* Estimates of net effective immigration have involved the use of survival rates for the individual age groups. Crude survival rates for the entire population 10 years of age and over can be readily determined from these. The ideal method of calculation would be by age groups. However, limited time and the fact that the uncertainty of immigration already has introduced a certain amount of error into the estimate, and indications that the application of the crude survival rate will involve only slight error, have resulted in a decision in favor of its use. The crude survival rate as used in this investigation, it will be remembered, is the number of survivors at the end of the decade per 100,000 in the population at the beginning of the decade.

TABLE 9

NET EFFECTIVE IMMIGRATION INTO CALIFORNIA AS A PER CENT OF UNITED STATES INCREASE IN POPULATION, 1860 TO 1930

Year	1	2	3	4
	United States population 10 years of age and over	Increase in United States population	Immigration 10 years of age and over	California 3 as a per cent of column 2
1860	22,429,653			
1870	28,258,640	5,828,987	71,082	1 22
1880	39,781,067	11,522,427	172,060	1 49
1890	47,618,554	7,837,487	217,455	2 77
1900	57,946,854	10,328,300	150,875	1 46
1910	71,384,320	13,437,466	716,660	5 33
1920	82,778,053	11,393,733	795,411	6 98
1930	97,885,000	15,106,947	1,757,758	11 63

NOTE: For method of calculating net effective immigration see Appendix A

rate. A more complete census enumeration in 1930 would have produced the same result, however. Attention has been called to the fact that changes in the composition of the population may also change the mortality rate. An important consideration in projecting the survival rate of the portion of the population which excludes children born during the decade, is that most of the improvement in mortality rates during the past decade has been in the first year of life, and so far as the United States as a whole is concerned there has actually been a setback.* Any improvement in the crude mortality rate in the population living in California at the beginning of the decade must therefore have come from reduced proportions of foreigners and decreased percentage of males. These, on the other hand, have been offset by increased average age of the population. As a result the crude survival rate has not varied during the past several decades by more than about 1 per cent. Survival rates applied in the estimates for the next four decades give from 87,700 to 88,000 survivors at the end of a decade for each 100,000 living at the beginning of the decade. The results of applying these to the estimate of future California population are summarized at the end of this chapter.

How Many Children Will There Be?

How many of our children under 10 years of age were born in California and how many have been brought here by their parents we do not know. Census statistics do not reveal this proportion and our vital statistics available in detail do not extend over a period sufficiently long to make possible a reliable estimate. It makes little difference, however, whether children immigrated to the state with their mothers or were born here, provided we get them all counted. As to the future estimate, if we can determine how many children can be expected in proportion to the number of women of childbearing age, then we can

* Dublin, L. I., A Setback in Mid-Life Mortality. American Journal of Public Health, Vol. XIX, No. 5, page 535, May, 1929.

TABLE 10

ESTIMATED FUTURE NET EFFECTIVE IMMIGRATION INTO CALIFORNIA

Thousands of persons 10 years of age and over

Year	Estimated future United States population	Increase in United States population	Extreme upper limit		Reasonable upper limit		Reasonable lower limit		Extreme lower limit	
			Net effective immigration	Per cent of United States increase	Net effective immigration	Per cent of United States increase	Net effective immigration	Per cent of United States increase	Net effective immigration	Per cent of United States increase
1930	97,985									
		13,678	2,462	18.00	2,394	17.50	2,230	16.30	1,460	10.66
1940	111,663									
		12,187	3,351	27.50	2,949	24.20	2,364	19.40	930	7.62
1950	123,850									
		11,108	4,721	42.50	3,221	29.00	2,177	19.60	650	5.85
1960	134,958									
		8,769	5,524	63.00	2,525	28.80	1,578	18.00	540	6.16
1970	143,727									

count the women and from their number estimate the number of children. Estimates here given for net effective immigration exclude this first ten-year age group because of the difficulty of separating immigration from California-born for ages under 10 years, and because of the possibility of estimating the number of these children by a more satisfactory method.

In Table 11 and Figure 1 of Plate VIII the numbers of children per 1000 women of childbearing age are given for several decades in the past. In order to reduce the work of estimating numbers of women by age groups for each of the four decades, a short cut, which probably has given us reliable results, has been used. Estimates of population for ages 10 and over were made according to methods described above. Child population was then computed from the trend of the ratio of children to total population. In 1880 this percentage was 21.24 and decreased to 16.22 in 1920. In 1970 this percentage was estimated at 15. This trend is shown in Table 11 and Figure 2 of Plate VIII. Having carried through the calculations for each decade to 1970, the female population was estimated by age groups for that year and the numbers of children per 1000 women of childbearing age computed. This was checked for consistency with the trend in that ratio for the earlier decades. The result is shown in Table 11 and Figure 1 of Plate VIII.

TABLE 11

CHILD POPULATION OF CALIFORNIA UNDER 10 YEARS OF AGE IN PER CENT OF TOTAL CALIFORNIA POPULATION AND IN RELATION TO NUMBERS OF WOMEN OF CHILDBEARING AGE

Year	1 Child population, ages 0-9	2 Total California population	3 Child population 0-9, as per cent of total population	4 Females, ages 15-50	5 Children 0-9, per 1,000 females 15-50
1880	183,472	864,694	21.24	182,351	990
1890	218,274	1,208,130	18.06	281,355	773
1900	232,842	1,485,053	17.71	327,508	706
1910	380,851	2,377,549	15.56	616,488	600
1920	538,108	3,426,861	16.22	887,787	612
1930	805,150	5,680,000	15.90	1,460,935	614

ESTIMATED FUTURE TREND

Year	6	7	8	9	10
1940	1,258,000	8,000,000	15.70		
1950	1,912,000	12,000,000	15.92		
1960	2,824,000	17,715,000	15.93		
1970	3,901,554	20,277,909	19.00	5,877,332	286

Sources of data and bases of estimates

Columns 1 and 2 are from the U. S. Census. The 1880 total California population is an approximate preliminary total from the 1880 census. Child population for 1880 has been interpolated on the basis of the trend of the ratio of child population to total population.

Column 3—column 1 ÷ column 2 x 100.

Column 4 is from the U. S. Census, the 1880 total having been estimated on the basis of the trend of sex ratio and of percentage age distribution of the female population over 10 years of age.

Column 5—column 1 ÷ column 4 x 1,000.

Column 6 was calculated from items in lines 5 and 7, Table 10.

Column 7 from Table 10.

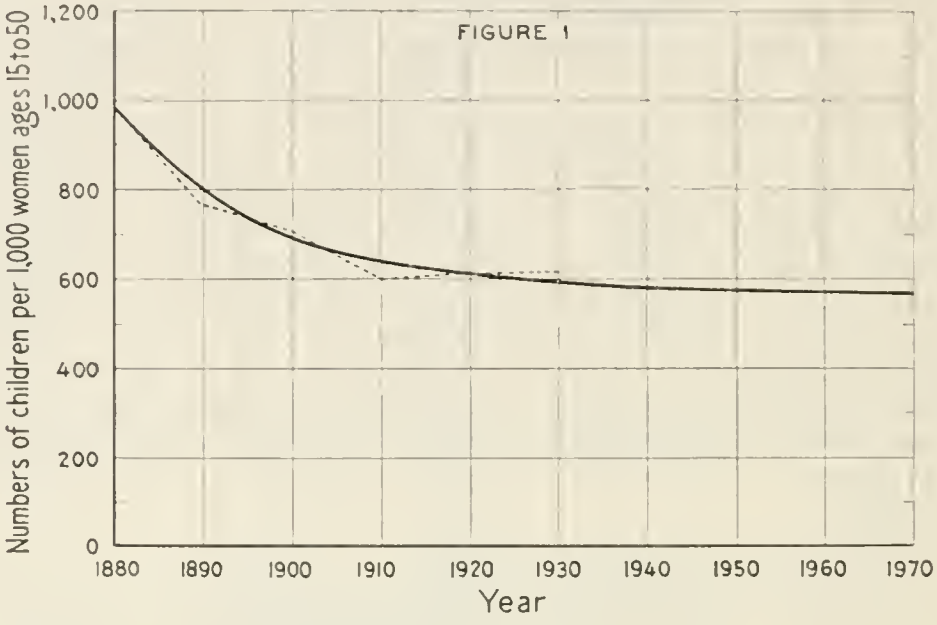
Column 8 is from Figure 2, Plate VII and also is equal to column 6 divided by column 7 above.

Column 9 has been estimated on the basis of trend of sex ratio and of percentage age distribution of the female population 10 years of age and over.

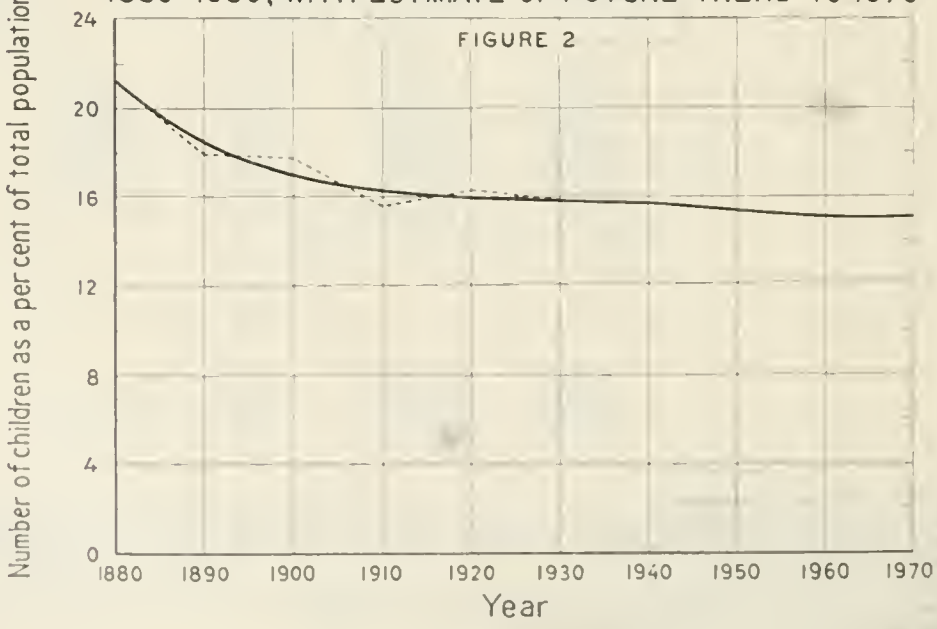
Column 10—column 6 ÷ column 9 x 1,000.

Plate VIII

TREND IN THE NUMBERS OF CHILDREN PER 1,000 WOMEN OF CHILD BEARING AGE IN CALIFORNIA, 1880-1930 WITH ESTIMATE OF FUTURE TREND TO 1970



TREND IN THE NUMBER OF CHILDREN IN THE CALIFORNIA POPULATION EXPRESSED AS A PERCENTAGE OF THE TOTAL POPULATION, 1880-1930, WITH ESTIMATE OF FUTURE TREND TO 1970



The computation of numbers of women in 1970 was based upon the trends in the percentage age distribution of the California female population 10 years of age and over shown in Table 12 and Figure 2 of Plate IX. On this plate also are shown in Figure 1, the percentage age distribution of the total California population 10 years of age and over, and in Figure 3, the California population 10 years of age and over as a per cent of the total California population. This last curve is based upon the ratios of children to total population. Its purpose is to determine total population direct from population 10 years of age and over without going through the intermediate calculation of numbers of children.

Recapitulation.

We have seen in Table 9 that for thirty years California net effective immigration, native and foreign, of those 10 years of age and over has been in excess of 700,000 per decade and that during the past decade this figure was increased by a million. This sudden increase in estimated immigration could have resulted in part from a more complete census in 1930 than in 1920. Surveys made by the Eberle Economic Service of Los Angeles, however, indicate that even the 1930 census was underestimated and that the deficiency was as great or greater than the 1920 enumeration. Again the 1920 to 1930 decade may have been a "brilliant episode" in the history of California never to return. For those who are optimistically minded, however, an outside maximum population of 26,300,000 is presented for 1970. This will require for the current decade an increase in immigration over the decade just passed of a little more than 700,000, followed by another increase between 1940 and 1950 of 890,000. Between 1950 and 1960, moreover, the increase would rise to more than 1,300,000, dropping again between 1960 and 1970 to about 800,000. This would bring the net effective immigration up to more than five million persons, or about as many as entered into the interstate migratory movement in the entire United States between 1910 and 1920, and would be approximately two-thirds the estimated population increase of the United States between 1960 and 1970. It is not believed this figure will be approached.

At the other extreme, for those who are very conservative, an estimate is given, based upon the premise that inasmuch as population growth has increased at about the same rate as the increase in acreage and production of California fruits that it will continue to do so. This would result in a population in 1970 of about 11,100,000. Such a rate of growth would require a net effective immigration during the current decade of 1,460,000, falling to 930,000 during the next ten-year period and to a little more than a half a million between 1960 and 1970. The writer believes this is too conservative and that although the fruit industry is one of California's basic industries, the inevitable decline in the rate of its growth will undoubtedly be offset to some extent by the development of industry and commerce.

The best inference that can be drawn from the evidence presented in the preceding pages and the facts set forth in the chapters which are to follow is that the trend of California population should be somewhere between 8,500,000 and 8,700,000 in 1940; between 11,500,000 and

TABLE 12

PERCENTAGE DISTRIBUTION BY 10-YEAR AGE GROUPS OF THE CALIFORNIA POPULATION 10 YEARS OF AGE AND OVER

	Total population over 10[1]						Females over 10[2]					
	1880	1890	1900	1910	1920	1930	1880	1890	1900	1910	1920	1930
10–19	23 68	22.51	20.86	18 42	17.51	15.45	30.15	27.32	23.52	20.65	18.46	16.83
20–29	24 17	24.64	22.16	23.94	20.28	20.31	24 03	25.55	24.16	23.70	21.26	19.80
30–39	21.06	19.94	20.63	21.24	21.47	22.00	19.40	17.93	19.81	20.76	21.03	21.78
40–49	16.32	14 45	15.23	16 00	17.23	17.40	14.52	13.26	13.65	15.31	16.52	16.83
50–59	9.59	9.70	9.99	10.03	11.97	12.54	7.40	8.95	9.39	9.67	11.47	12 47
60–69	3.91	5.94	6.88	6.33	7.09	7.69	3.06	4.63	6.00	6.13	6.90	7.33
70–79	1.04	1.66	2.85	2.87	3.24	3.80	1.13	1.55	2.39	2.84	3.23	3 56
80–89	0 21	0.32	0.52	0.70	0 81	0.74	0.27	0.37	0 52	0.69	0.84	1 00
90+	0.02	0 84	0.88	0.47	0.40	0.07	0.04	0.44	0.56	0.25	0.29	0.40
Totals	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

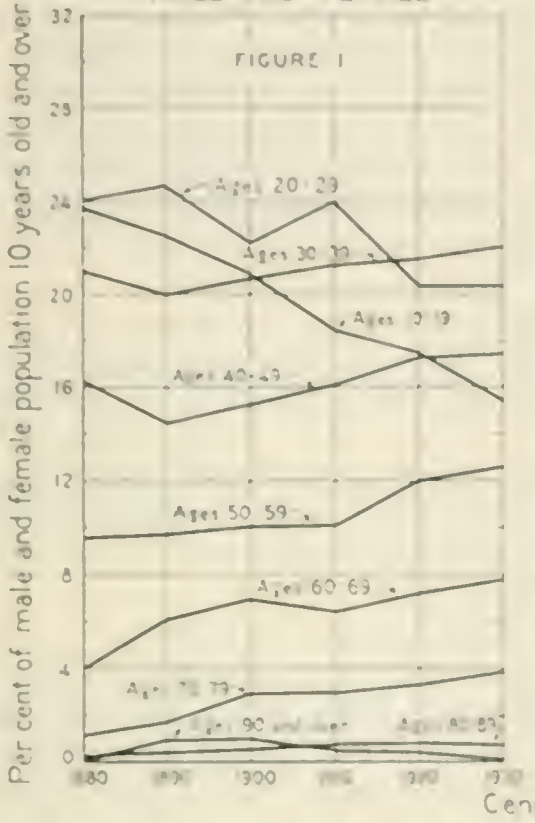
[1] Total population 10 years of age and over equals 100 per cent.
[2] Female population 10 years of age and over equals 100 per cent.

Plate IX

PERCENTAGE AGE DISTRIBUTION OF CALIFORNIA POPULATION TEN YEARS OF AGE AND OVER

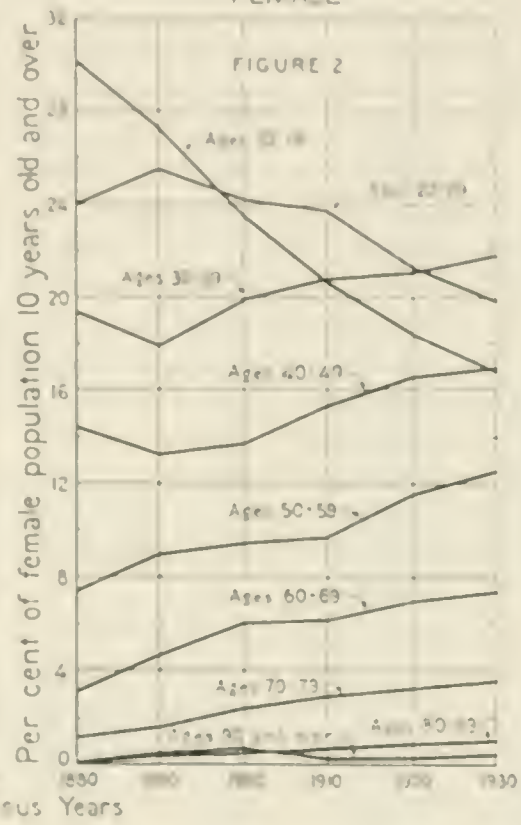
MALE AND FEMALE

FIGURE 1



FEMALE

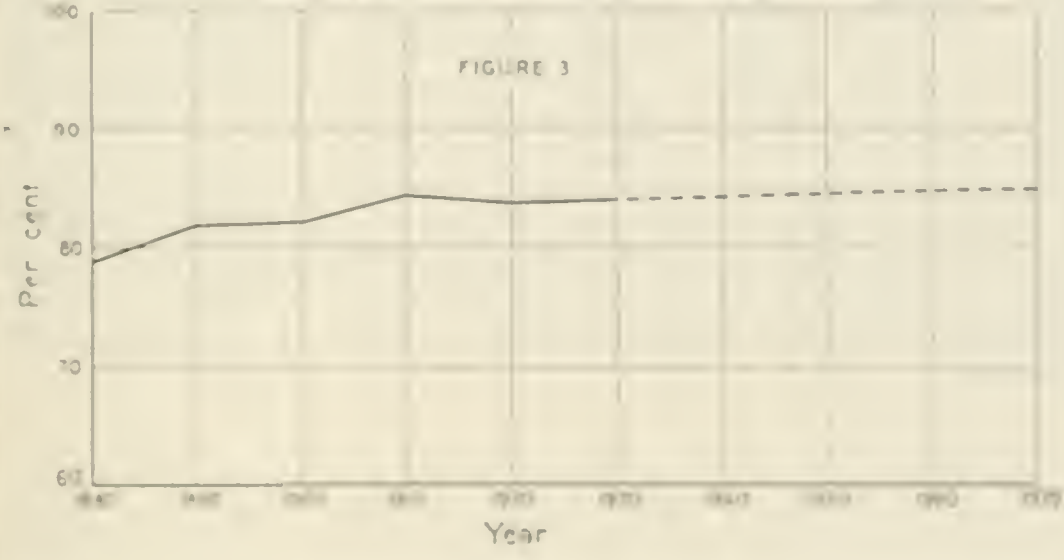
FIGURE 2



Census Years

CALIFORNIA POPULATION TEN YEARS OF AGE AND OVER AS A PER CENT OF TOTAL CALIFORNIA POPULATION SHOWING ESTIMATED FUTURE TREND

FIGURE 3



12,500,000 in 1950; between 14,500,000 and 16,750,000 in 1960, and between 17,000,000 and 20,500,000 in 1970.

The estimate calls for an increase in net effective immigration for the current decade of about half the increase of the past decade. This would mean that California immigration would be between 16.3 and 18.0 per cent of the estimated increase in United States population. While this is somewhat greater than the corresponding percentage for the past decade, it is justified on the basis of the following evidence:

1. An upward trend in the ratio of California immigration to United States population increase extends through many decades of the past.

2. There is a probability of a temporary increase in the number of children per 1000 in the United States population during the latter part of the current decade and the early part of the next.

3. The large reservoir of population upon which California draws for its supply of immigrants will be only slowly affected as a source of California immigration by a reduction in the rate of increase of the United States population.

4. California's resources of land, water and water power, while affected in their value by trends in the markets for the products derived from them and by increasing costs of development, are still far from being exhausted.

5. Advantages for industry and commerce are increasing.

6. The widely advertised advantages of California as a place of residence will continue to operate toward an increase in the westward trek.

7. The country to city migration and business depression in the east will probably continue for some time to increase the supply of opportunity seekers.

Just what effect business depression may have upon migration is not known, however. During the early land-settlement movement a wave of migration swept westward at each period of hard times. The difficult times of 1873 were accompanied by a relatively heavier migration to California than was the case during the hard times of the nineties. The answer today probably may be found in the relative severity of the depression in different parts of the country. In a previous paragraph it has been stated that no attempt has been made to forecast deviations from the predicted trends. If population falls below the estimates given because of economic conditions, experience of the past shows that the return of good times will make up for the loss by a more than normal immigration. With this again impressed upon the reader's mind, he may find interest in the details of the four projected population estimates given in Table 13 and illustrated in Plate X.

TABLE 14

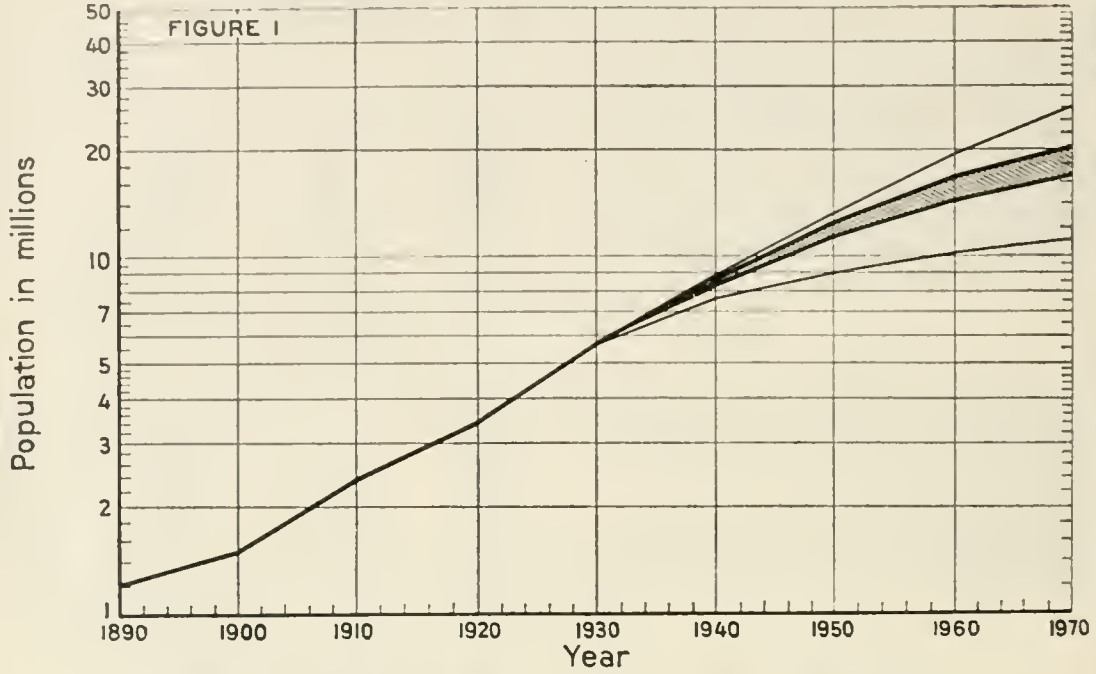
ESTIMATED FUTURE CALIFORNIA POPULATION, 1940 TO 1970, IN THOUSANDS

	1940 to 1950	1950 to 1960	1960 to 1970	1940 to 1970
		Extreme lower limit		
1 Population beginning of decade—permanent residents, 14 years and over, civilian nonfarm	5,950	7,060	8,600	10,100
2 Estimated crude survival rate per 100,000 for decade (for method see Appendix A)	87,700	87,900	88,000	88,000
3 Survivors end of decade, 10 years of age and over (Line 1 x Line 2 ÷ 100,000)	5,060	6,680	7,600	8,960
4 Net effective immigration (from Table 16)	1,400	660	660	540
5 Population 10 years of age and over (Line 3 + Line 4)	6,410	7,340	8,370	9,440
6 Population 10 years of age and over as a per cent of total population (from Parts VIII and IX)	84.30	84.65	84.90	85.00
7 Total population (Line 5 ÷ Line 6)	7,600	8,670	10,100	11,100
		Reasonable lower limit		
1 Population beginning of decade	5,650	8,520	11,660	14,520
2 Estimated crude survival rate per 100,000 for decade	87,700	87,900	88,000	88,000
3 Survivors end of decade, 10 years of age and over	4,960	7,480	10,140	12,840
4 Net effective immigration	2,200	2,681	2,177	1,578
5 Population 10 years of age and over	7,180	9,854	12,317	14,378
6 Population 10 years of age and over as a per cent of total population	84.30	84.65	84.90	85.00
7 Total population	8,520	11,650	14,520	16,900
		Reasonable upper limit		
1 Population beginning of decade	5,650	8,700	12,500	16,770
2 Estimated crude survival rate per 100,000 for decade	87,700	87,900	88,000	88,000
3 Survivors end of decade, 10 years of age and over	4,960	7,640	11,000	14,750
4 Net effective immigration	2,200	2,949	3,221	2,525
5 Population 10 years of age and over	7,244	10,589	14,221	17,275
6 Population 10 years of age and over as a per cent of total population	84.30	84.65	84.90	85.00
7 Total population	8,700	12,500	16,700	20,300
		Extreme upper limit		
1 Population beginning of decade	5,950	8,730	13,070	16,110
2 Estimated crude survival rate per 100,000 for decade	87,700	87,900	88,000	88,000
3 Survivors end of decade, 10 years of age and over	4,960	7,710	11,460	14,840
4 Net effective immigration	2,200	3,681	4,751	5,521
5 Population 10 years of age and over	7,162	11,081	15,721	22,054
6 Population 10 years of age and over as a per cent of total population	84.30	84.65	84.90	85.00
7 Total population	8,500	13,070	18,510	26,000

[a] Net effective immigration required to maintain consistent growth at the same rate as the estimated rate of increase of the California labor force.

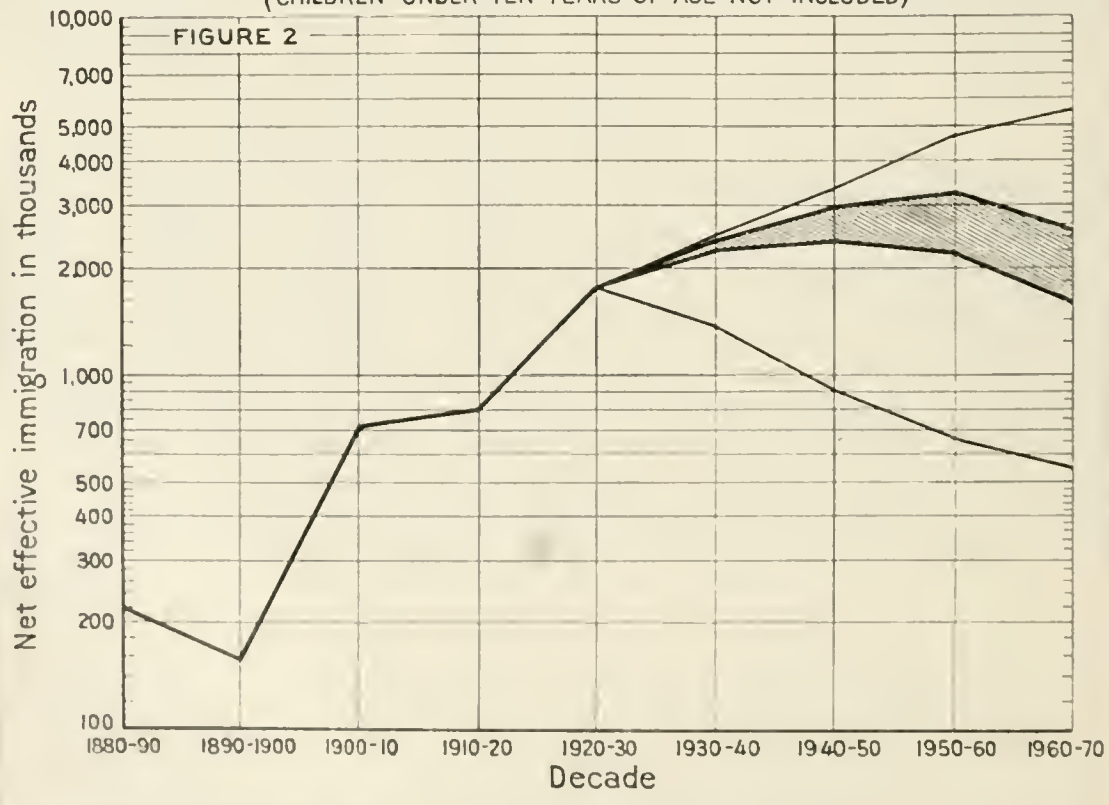
Plate X

CALIFORNIA POPULATION 1890 TO 1930 AND ESTIMATED FUTURE POPULATION SHOWING REASONABLE LIMITS OF FUTURE GROWTH



NET EFFECTIVE IMMIGRATION TO CALIFORNIA 1880 TO 1930 SHOWING FUTURE IMMIGRATION NECESSARY TO ATTAIN POPULATIONS SHOWN IN FIGURE 1

(CHILDREN UNDER TEN YEARS OF AGE NOT INCLUDED)



CHAPTER IV

TRENDS IN CALIFORNIA CROP LAND UTILIZATION, 1909–1929

Irrigation development and a shift to intensive crops under irrigation, the retirement of the horse in favor of the truck, tractor and automobile, changes in the amount and kind of feed required to produce butterfat, the growth of the beef fattening business in lieu of beef raising and important developments within the fruit and vegetable industries all have contributed to bring about outstanding changes in the use of California crop lands during the past 20 years. These changes in land utilization have made possible an increase during the same period of more than 100 per cent in production with only a 15 per cent increase in acreage of harvested crops.

At the same time large investments of capital have completely changed the basis on which costs of agricultural production and returns therefrom may be calculated. This has given rise to many errors on the part of those who have assumed increased production per acre and increased output per man working on the farm indicate a proportionate increase in efficiency of agricultural production. In reality the fundamental change which has taken place has been the more intensive application of capital to land and the transfer of many of the processes in agricultural production to urban centers. This has brought about a much different relation between the volume of agricultural production and the land area involved, the investment per acre and the number of people engaged in that part of the agricultural production process which still requires their residence in the country. It has not necessarily been in all cases an increased output measured in terms of the total investment.

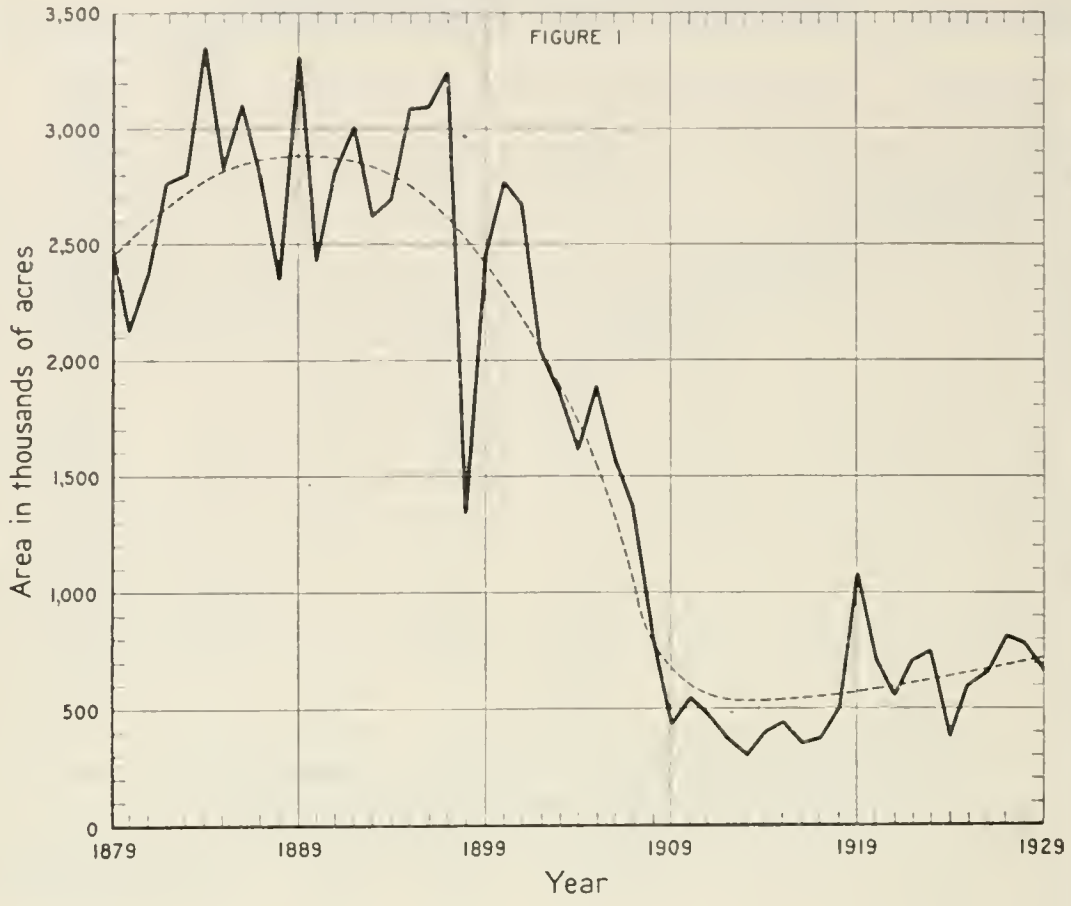
Most of the chapters of this report are concerned with the measurement of these changes with a view to estimating the importance an acre of land may have in the California agriculture of the future. This knowledge, together with estimates of population growth, should make possible an approximate estimate of requirements for irrigated land.

Variation in Acreage.

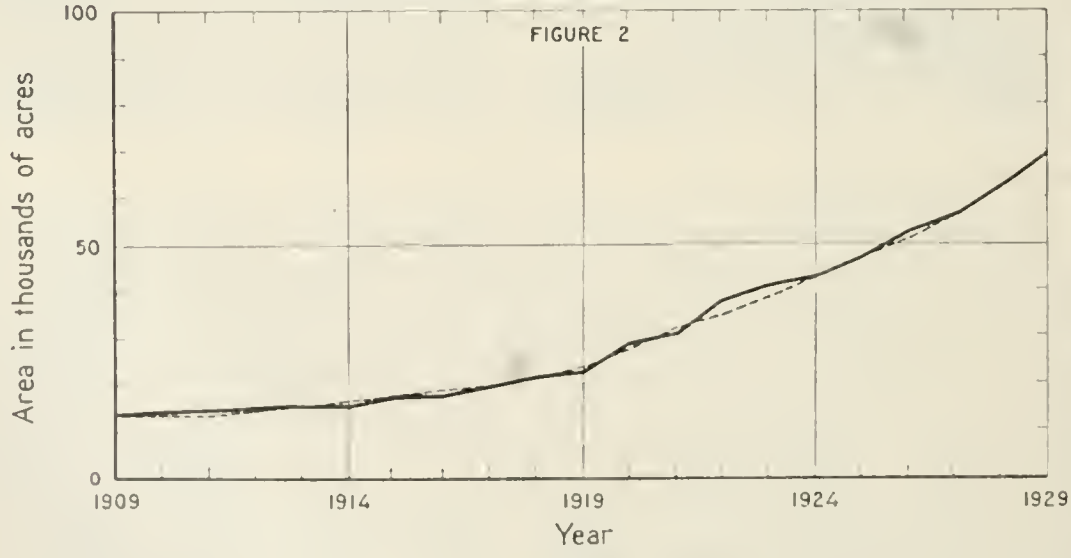
The year to year changes in acreage of annual crops are in most cases violent. These are in response to changes in the economic situation of the crops grown, the degree of success which has followed plantings in previous years and, to a certain extent, weather conditions the current year. In addition to these minor changes in acreage, there are cyclical changes which indicate an economic condition requiring more than a year to come into equilibrium. Finally, there are important changes taking place which require many years for their completion. These shifts in most cases are in response to permanent changes in the basic conditions of land utilization, such as improvements in agricultural production, development of competitive areas, permanent substitutions in the use of the products produced and many other influences. In a prediction attempting to look four decades into the future, the year to year variations of course cannot be foreseen. The shorter cycles are

Plate XI

HARVESTED ACREAGE AND TREND IN THE HARVESTED ACREAGE OF WHEAT IN CALIFORNIA



BEARING ACREAGE AND TREND IN THE BEARING ACREAGE OF PEARS IN CALIFORNIA



impossible of prediction for more than a few years at the very outside. It is the trend which becomes important in the long-time forecast, and it is from this point of view that the studies of land utilization have been carried out.

The illustrations in this chapter and many of the figures used are the acreages which would have prevailed had the major tendencies in land utilization been followed without the saw-tooth variation so characteristic of the annual crops. The elimination of these sharp variations was necessary to avoid confusion and to bring out the major changes.

Perennials are subject to important variations from the trend, but year to year variations are less pronounced. Plate XI shows the variations in the California harvested acreage of wheat, an annual crop, over a period of many years, in contrast to the acreage of pears, a perennial crop. The trends in the acreages are shown for comparison. This illustration is given not so much to point out the facts concerning these two crops, but to enable the reader to interpret properly the illustrations which are to follow and in which minor variations in acreage do not appear. In the construction of the plates, the trend values for the individual crops have been added. The changes in the areas between the lines in the illustrations, therefore, show the trends for each crop of the group, while the trend for the entire group is shown by the height of the upper curve above the base line. This method of presentation has certain disadvantages, but the influence that each crop has had upon the entire group could be shown in no other way.

Relation of Acreage of Harvested Crops to Gross Area.

Crop surveys made by the use of automobile and speedometer in the Sacramento Valley show an excess of about 25 per cent in the gross acreage devoted to the production of fruit over the recorded acreage of harvested fruit crops. The total crop land area is 27 per cent greater than the total area of harvested crops recorded by the State Crop Reporting Service. Similar differences are shown for the San Joaquin Valley. There are a number of reasons for these differences, however, which if taken into consideration make acreages useful measures of land utilization, whether derived from one or the other of these sources. Each is an approximation, and neither is claimed to be an exact measurement of acreage. One is an estimate of the actual acreage harvested, the other an estimate of gross area including roads, buildings and small uncultivated fields which are not of sufficient size to record. One includes all orchards and vineyards, bearing, nonbearing, and abandoned. The other includes only bearing orchards and vineyards and only includes the important crops. Nevertheless the estimates of crop land harvested as recorded in the census and by the State Crop Reporting Service should be a valuable index of gross requirements. These published and heretofore unpublished records of harvested crop acreage for the state and for the two interior valleys, together with some additional data from other sources, form the basis of the analysis in this chapter, which is interpreted in a later chapter in terms of gross acreage requirements.

Over periods of time the ratio of gross acreage to acreage of harvested crops is variable. One of the important reasons for these changes is the reduction in the amount of fallow land. Furthermore,

there are changes in the acreages of non-bearing fruits. Plates XII and XIII show the trends in the non-bearing acreages of fruit in California and in the San Joaquin Valley. Since 1924 the non-bearing fruit acreage has been dropping rapidly.

Trend in the Acreage of Total Crop Land Harvested in California.

The total acreage of land devoted to harvested crops in the state of California has not changed greatly during the past 20 years. It has already been stated that the increase in acreage of harvested crops was only about 15 per cent during this period. The crop acreage reached a peak in the years 1918 and 1919,* but fell slightly until 1924, when a rise set in again. In 1929 the total area in harvested crops was nearly 7,000,000 acres. The acre is a poor measure of land, however, unless some knowledge can be gained concerning its character and uses. The reasons why California has been able to bring about such a phenomenal increase in production with so small an increase in cropped area can be understood by noting the changes which have taken place in the acreages of the important groups of crops. To facilitate the study of these changes, acreages and trends in the acreages of the total crop land harvested and of the important crop groups are presented in Table 14, while the trends are shown graphically in Plate XIV.

Although the total acreage has not varied greatly, many important changes are found in the trends of the acreages of the crops making up that total. While sub-tropical fruits and nuts, temperate zone fruits, vegetables and miscellaneous field crops, consisting of beans, sugar beets and cotton, have increased in acreage considerably over this period, the acreage devoted to cereals and hay and forage crops has decreased.

To give a better picture of the changes that have occurred in the acreage utilized by the various groups of crops in California, Table 15 is given. This shows the percentage increase or decrease in the acreage for the periods 1909 to 1929, 1909 to 1919, and 1919 to 1929.

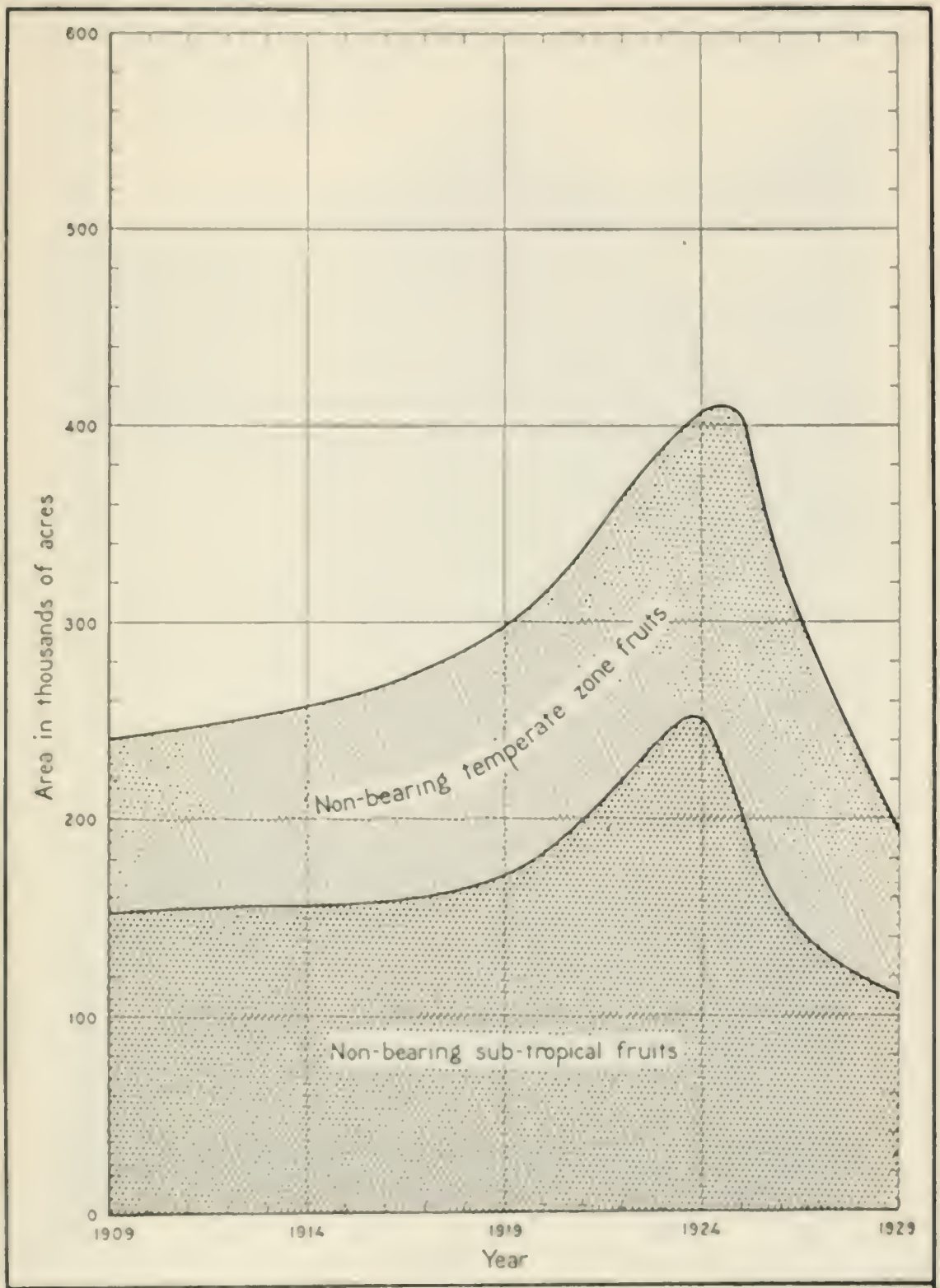
In the year 1909 the area devoted to cereals and hay and forage crops represented approximately 80 per cent of the total cropped acreage, while in 1929 this percentage had fallen to a little less than 60 per cent of the total cropped area. Most of this decrease in acreage occurred in hay and forage crops. Table 15 also shows that the combined acreage devoted to sub-tropical fruits and nuts, temperate zone fruits, and vegetables more than doubled from 1909 to 1929, while the acreage in the miscellaneous field crops, beans, sugar beets and cotton, increased approximately 66 per cent over the entire period. All of this increase occurred, however, in the earlier decade.

Sub-tropical Fruits and Nuts.

The acreage devoted to the production of California sub-tropical fruits and nuts has more than doubled in the past twenty years, occupying an area of more than 1,100,000 acres in 1929. While the grape acreage accounts for more than half of this expansion, there has been a pronounced increase in the acreage of the other sub-tropical fruits and nuts. Citrus fruits have increased over 400 per cent; the important nut

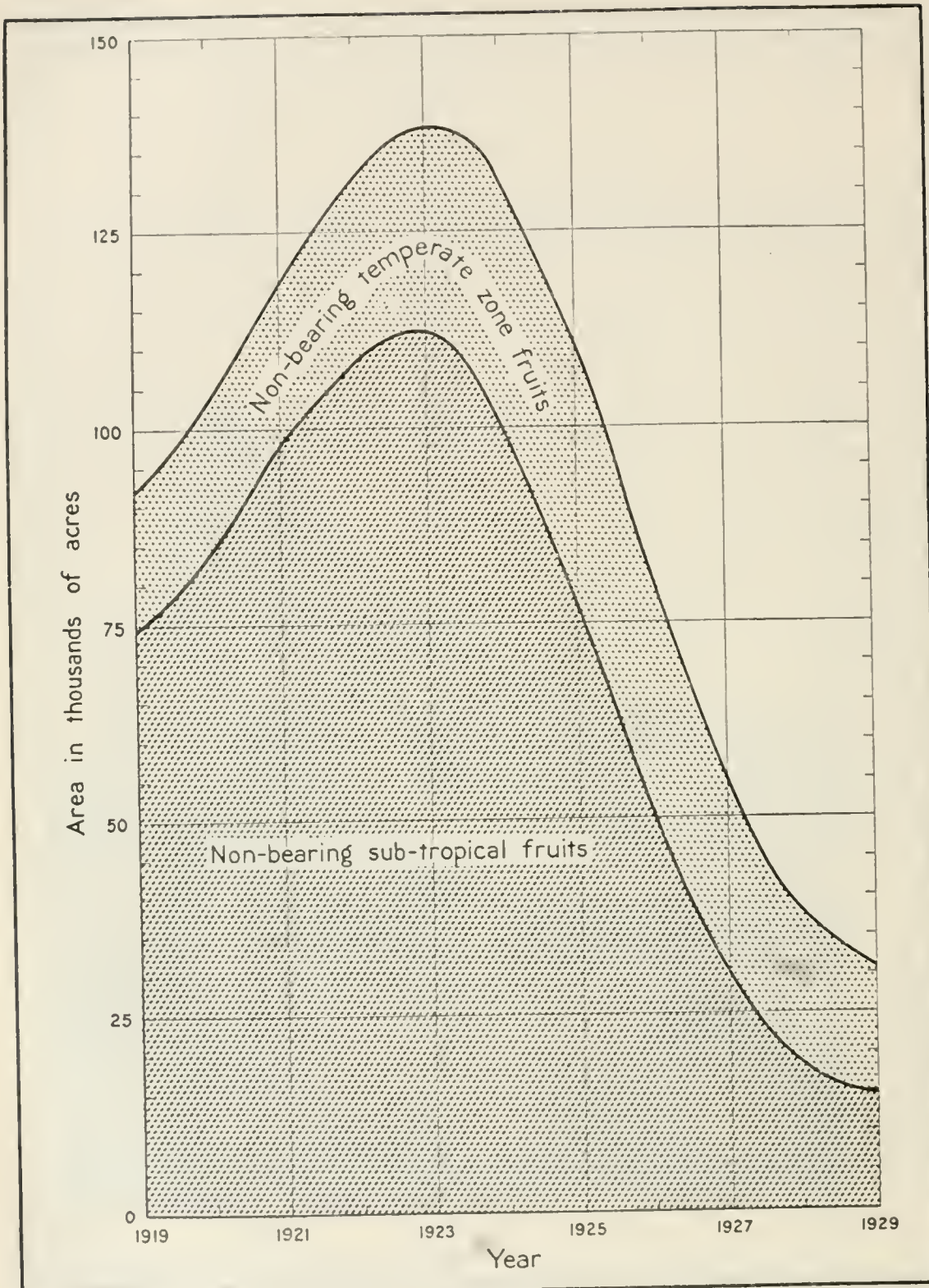
* It will be seen throughout the following pages of this chapter that the period of inflation following the war has been recorded even in the trend of crop acreages. The peak of 1919, however, has been very much reduced in the fitting of trends in the illustrations and computing percentage increases.

Plate XII



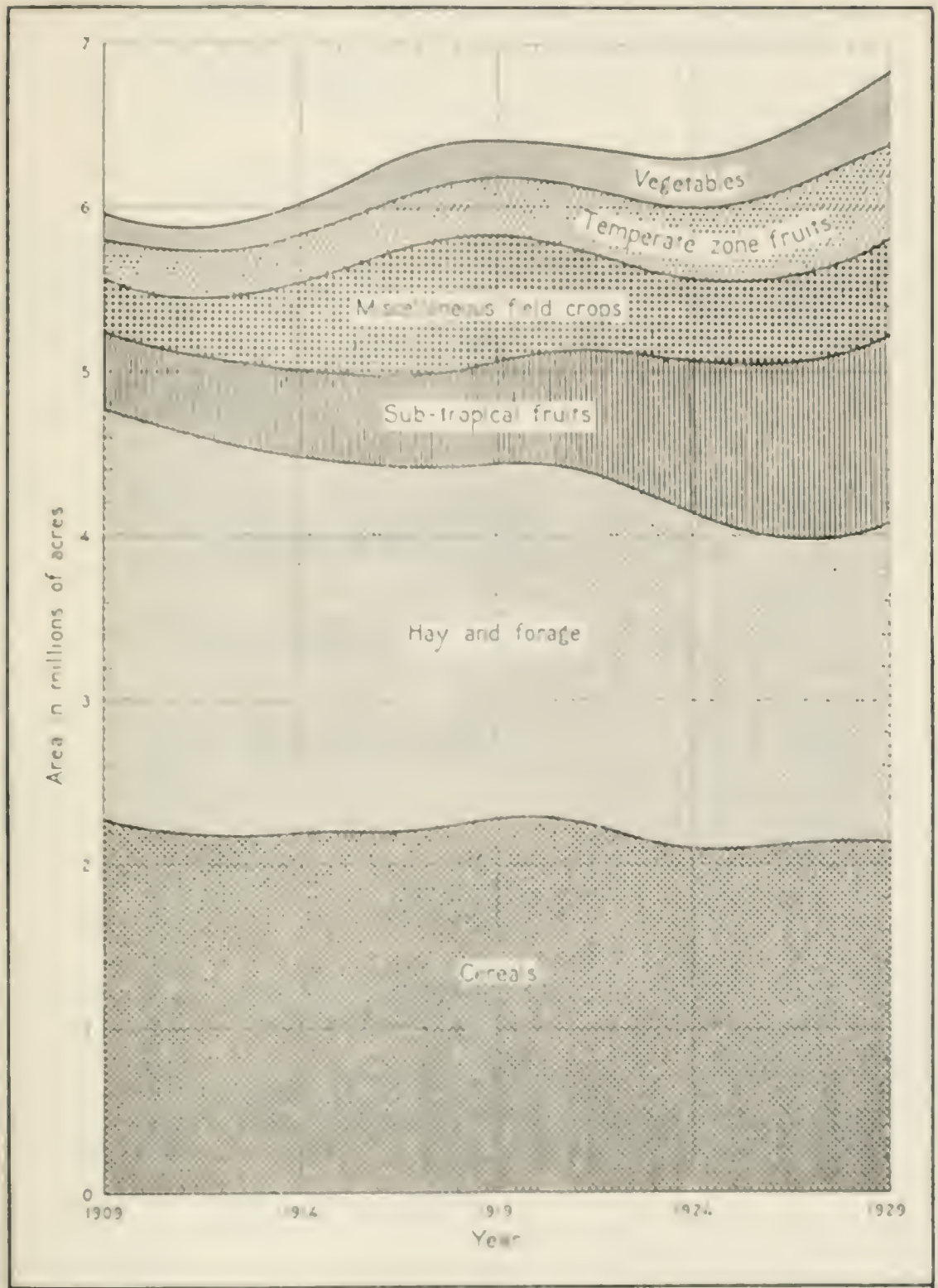
TRENDS IN THE NON-BEARING ACREAGES
OF THE
SUB-TROPICAL AND TEMPERATE ZONE FRUITS
IN
CALIFORNIA

Plate XIII



TRENDS IN THE NON-BEARING ACREAGES
OF THE
SUB-TROPICAL AND TEMPERATE ZONE FRUITS
IN THE
SAN JOAQUIN VALLEY

Plate XIV



TRENDS IN THE ACREAGES
OF THE
TOTAL CROP LAND HARVESTED
CLASSIFIED ACCORDING TO MAJOR GROUPS
IN
CALIFORNIA

TABLE 14

ACREAGES AND TRENDS IN THE ACREAGES OF THE TOTAL CROP LAND HARVESTED IN CALIFORNIA, 1909-1929

In Thousands of Acres

Year	Sub tropical fruits		Temperate zone fruits		Vegetables		Miscellaneous field crops		Hay and forage		Cereals		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	492	465	242	220	152	152	353	361	2,503	2,492	1,915	2,281	5,657	5,971
1910	----------	473	----------	241	----------	160	332	362	----------	2,411	----------	2,238	----------	5,885
1911	----------	482	----------	263	----------	170	433	374	----------	2,415	----------	2,221	----------	5,925
1912	----------	489	----------	283	----------	180	348	383	----------	2,376	----------	2,218	----------	5,929
1913	----------	498	----------	300	----------	190	339	439	----------	2,345	----------	2,213	----------	5,985
1914	514	511	311	312	----------	200	495	542	----------	2,308	----------	2,222	----------	6,095
1915	527	524	328	324	----------	210	620	619	----------	2,274	----------	2,214	----------	6,165
1916	532	539	339	334	----------	220	644	712	----------	2,238	----------	2,210	----------	6,252
1917	562	558	344	338	----------	230	915	795	----------	2,205	----------	2,226	----------	6,353
1918	585	587	343	344	----------	240	893	819	----------	2,160	----------	2,235	----------	6,385
1919	616	623	349	349	249	242	764	761	2,138	2,161	2,693	2,230	6,809	6,366
1920	677	669	359	357	260	249	698	688	----------	2,148	2,570	2,215	[1]6,712	6,326
1921	718	721	373	375	237	258	533	623	----------	2,155	2,276	2,197	[1]6,292	6,329
1922	783	781	400	393	284	268	583	567	----------	2,155	2,377	2,176	[1]6,582	6,340
1923	824	841	418	415	280	281	593	527	----------	2,122	2,374	2,157	[1]6,611	6,343
1924	919	918	437	438	286	298	419	502	2,088	2,075	1,417	2,140	5,566	6,371
1925	1,016	1,000	466	466	320	331	488	495	1,925	1,975	2,066	2,132	6,281	6,399
1926	1,083	1,064	504	499	382	368	513	502	1,849	1,904	2,211	2,115	6,542	6,452
1927	1,120	1,111	541	534	421	406	483	527	1,796	1,850	2,320	2,125	6,681	6,553
1928	1,135	1,131	573	557	425	436	574	566	1,804	1,893	2,310	2,123	6,821	6,706
1929	1,139	1,131	570	569	471	460	691	600	2,002	1,948	2,109	2,131	6,982	6,839

[1] Trend figures for hay and forage were used in obtaining total acreage for 1920 to 1923, inclusive.

Source of data:

Compiled from Tables 4B to 9B, inclusive, Appendix B of this report.

TABLE 15

PERCENTAGE OF TOTAL HARVESTED CROP AREA IN CALIFORNIA DEVOTED TO DIFFERENT GROUPS OF CROPS AND PERCENTAGE INCREASE OR DECREASE IN ACREAGES OF THE DIFFERENT GROUPS

Crop group	Percentage of total acreage of crop land harvested			Percentage increase or decrease in acreage of harvested crops		
	1909	1919	1929	1909-29	1909-19	1919-29
Total crop land harvested	100	100	100	15	8	1
Sub-tropical fruits	8	10	17	143	34	82
Temperate zone fruits	4	5	8	159	59	63
Vegetables	2	4	7	203	59	91
Miscellaneous field crops	6	12	9	66	111	—21
Hays and forage	42	34	28	—22	—13	—10
Cereals	38	35	31	—6	—0 2	—6

(Minus sign indicates a decrease.
Percentages are computed on basis of trends.

TABLE 16

THE RELATION OF THE CALIFORNIA ACREAGES OF THE INDIVIDUAL SUB-TROPICAL FRUITS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE IN THE ACREAGE OF EACH

Group and crop	Percentage of total sub-tropical fruit acreage			Percentage increase in acreage		
	1909	1919	1929	1909-29	1909-19	1919-29
Sub-tropical fruits and nuts	100	100	100	143	34	82
Lemons	2	5	4	258	209	26
Oranges	15	23	17	163	103	29
Grapefruit	1	1	1	4 400	900	350
Walnuts	5	8	8	258	117	65
Almonds	4	5	8	385	60	191
Grapes	69	52	36	99	3	94
Olives	3	3	2	107	43	46
Figs	1	2	4	840	100	370

Percentages are computed on basis of trends.

crops over 600 per cent; olives about 107 per cent and figs approximately 840 per cent from 1909 to 1929. During this same period, vineyards increased in acreage almost 99 per cent. By far the greatest part of this increase came during the second decade of the twenty-year period. Up until 1920 the increase in the acreage trend of the group had amounted to only 34 per cent. These trends are shown graphically in Plate XV and are also indicated in Table 16.

Temperate Zone Fruits.

Temperate zone fruits in California covered an area of approximately 570,000 acres in 1929, which represented about 8 per cent of the total crop land harvested. With the exception of the apple acreage, which increased only about 65 per cent, all the fruits in this group more than doubled in acreage during the two decades. Table 17 and Plate XVI show the relative increases in the acreage of the fruits in this group for different periods.

About 37 per cent of the acreage in this group is devoted to the production of plums and prunes, and approximately 24 per cent is in peaches. Although the pear acreage represents only about 12 per cent

TABLE 17

THE RELATION OF THE CALIFORNIA ACREAGES OF THE INDIVIDUAL TEMPERATE ZONE FRUITS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE IN THE ACREAGE OF EACH

Group and crop	Percentage of total temperate zone fruit acreage			Percentage increase in acreage		
	1909	1919	1929	1909-29	1909-19	1919-29
Temperate zone fruits	100	100	100	159	59	63
Cherries	2	2	2	160	80	44
Pears	6	7	12	393	73	187
Apricots	18	13	15	116	11	95
Apples	16	13	10	63	29	27
Peaches	28	30	24	119	68	31
Prunes and plums	30	35	37	221	83	75

Percentages are computed on basis of trends.

TABLE 18

THE RELATION OF THE CALIFORNIA ACREAGES OF THE INDIVIDUAL VEGETABLES TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGE OF EACH

Group and crop	Percentage of total vegetable acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Vegetables	100	100	100	203	59	91
Asparagus		7	13			253
Cantaloupes		10	11			72
Lettuce		4	18			740
Peas		4	7			300
Potatoes, white		32	13			—22
Tomatoes		15	11			45
Others		28	27			

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

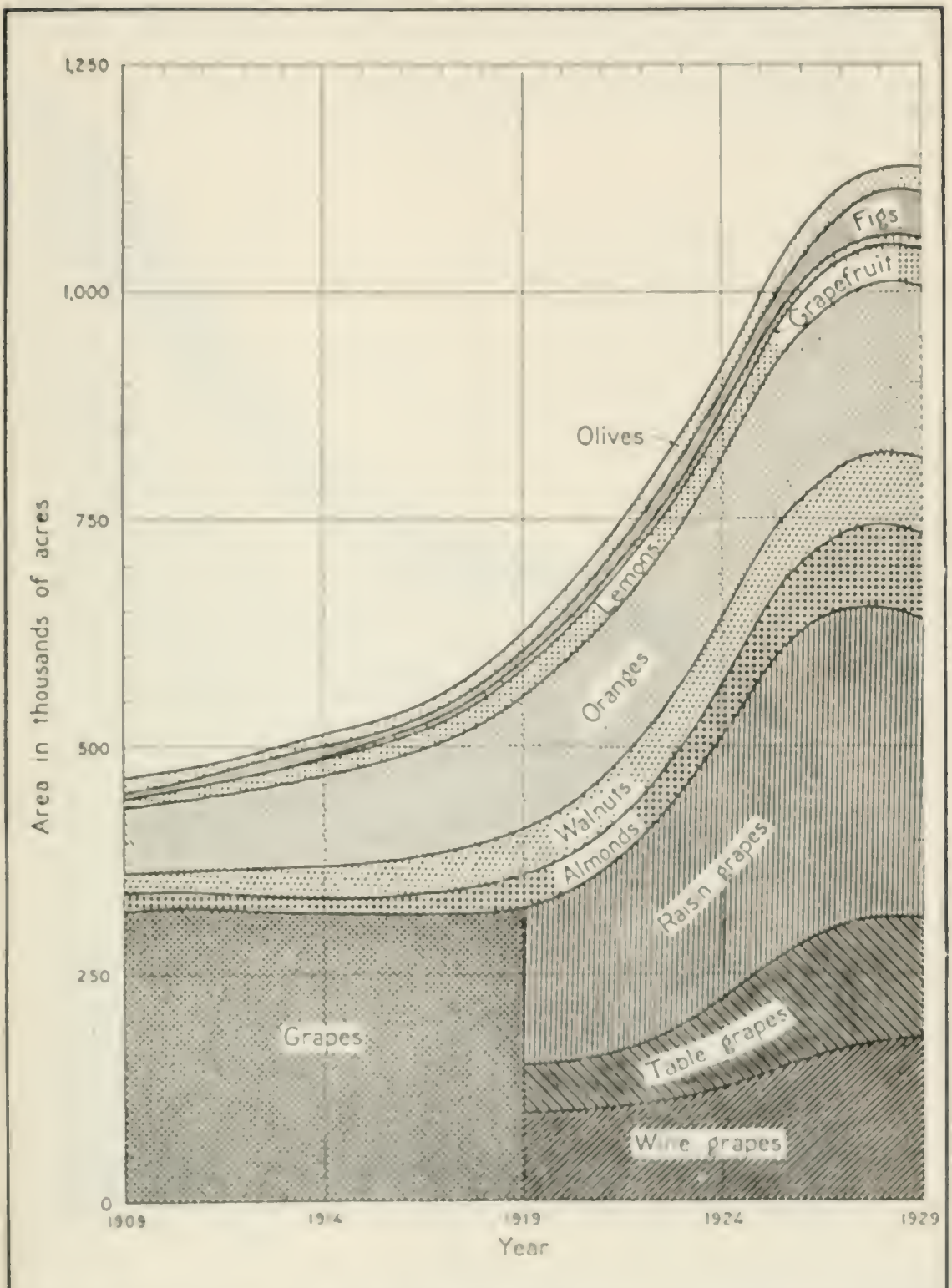
of the total temperate zone fruit acreage, during the past 20 years it has increased over 390 per cent, the most important expansion coming in the last decade.

Vegetables and Truck Crops.

In comparison to the acreage of the total crop land harvested, the area in vegetable crops is of minor importance, being a little less than 7 per cent of the total in 1929. But when comparing the crop groups on the basis of rate of increase in acreage during the past 20 years, the acreage in vegetables has undergone a remarkable development. This may be seen by observing Table 18. During this period, the acreage has increased over 200 per cent, which is greater than the increase in acreage devoted to temperate zone fruits.

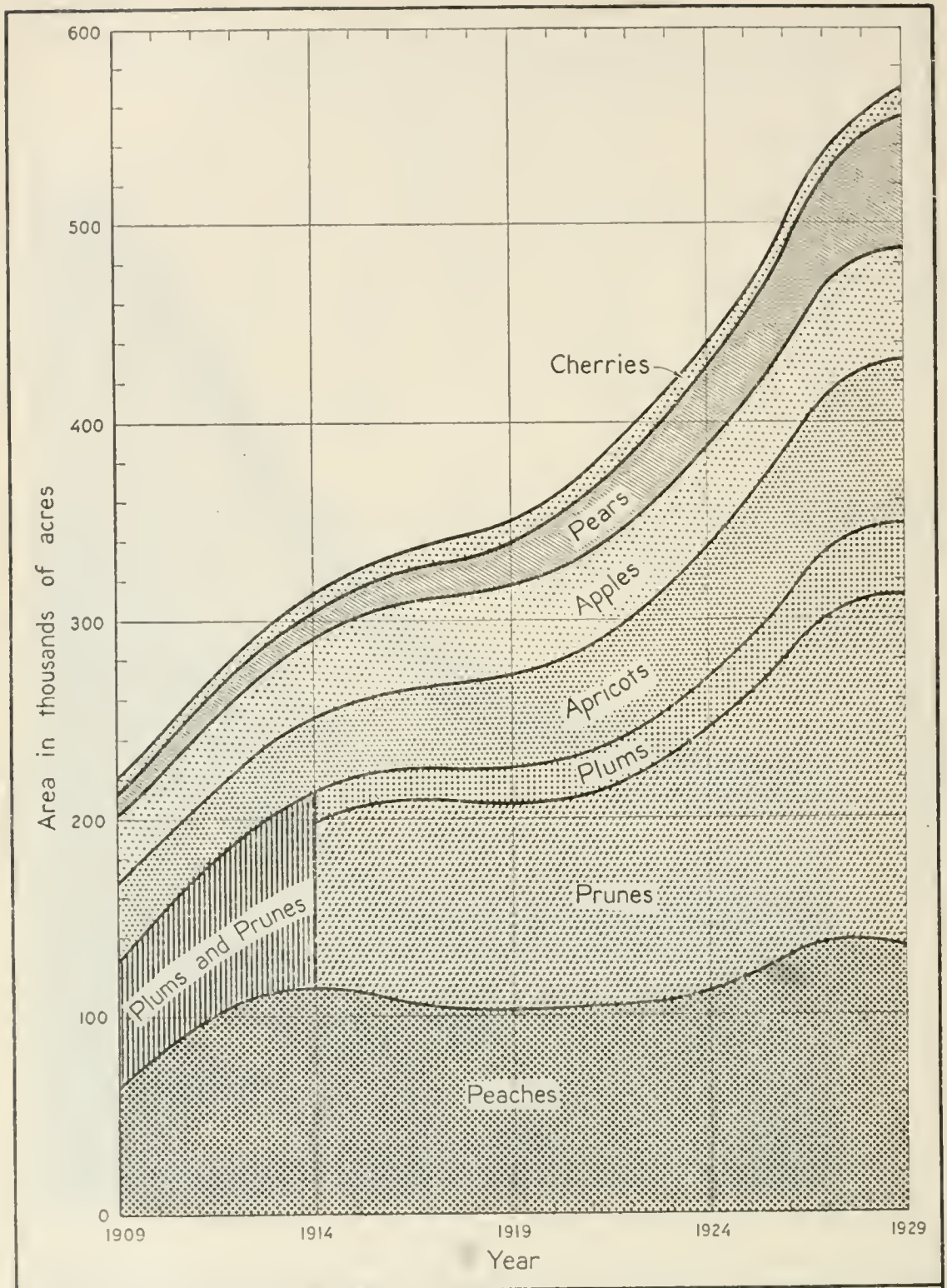
The crops making up most of this acreage are asparagus, cantaloupes, lettuce, peas, white potatoes and tomatoes. These six crops utilized about 83 per cent of the area devoted to vegetables. Potatoes, usually classified as a field crop, are included here because of the extent to which other vegetables seem to be competing with them. Although the potato acreage is an important one in this group, the trend in its

Plate XV



TRENDS IN THE BEARING ACREAGES
OF THE
SUB-TROPICAL FRUITS
IN
CALIFORNIA

Plate XVI



TRENDS IN THE BEARING ACREAGES
OF THE
TEMPERATE ZONE FRUITS
IN
CALIFORNIA

acreage has declined at the rate of about 22 per cent since 1919. At the same time that a decrease in the potato acreage was occurring, the trend in the lettuce acreage in the state had increased over 700 per cent, until in 1929 it occupied about 18 per cent of the total vegetable acreage, or approximately 84,000 acres. Plate XVII illustrates the growth of the vegetable acreage.

Miscellaneous Field Crops.

Miscellaneous field crops in this chapter include beans, sugar beets and cotton. Of these, beans are of major importance, occupying in 1929 approximately 334,000 acres. The area devoted to beans has fluctuated a great deal during the period from 1909 to 1929. In 1909 there were approximately 275,000 acres of beans in the state. This area quickly expanded until in 1918 it exceeded the 600,000 acre mark. From 1918 to 1924 the acreage decreased as quickly as it had increased in the previous decade, but since 1924 the acreage has again increased.

Cotton has little in common from the economic standpoint with beans or sugar beets, except that all are annual crops and compete to a limited extent for the same land. Because they are annual crops all have wide variations in acreage and the resulting trends, especially of the total for the group, have not the significance of those of the other crop groups. Trend-fitting, with respect to these crops, has therefore been especially difficult. From 1909 to 1920 the trend of the cotton area increased from 8000 acres to 210,000 acres. The 1910 acreage in cotton as recorded by the United States Department of Agriculture was 9000 acres and that of 1920, 275,000. Since 1920 the acreage has dropped off to some extent, but in recent years the acreage has again been increasing and in 1929 the recorded acreage was a little more than 300,000. The trends in Plate XVIII, although showing considerable variations in themselves and including a certain amount of cyclical variation, indicate average acreages and follow the course of the more general changes.* It will be noticed that the acreages used in the above discussion deviate to some extent from these trends.

Sugar beets reached their maximum expansion in 1917. Since that year, when about 190,000 acres of land was in sugar beets, the acreage has fallen off very rapidly until in 1929 there were only 48,000 acres devoted to the production of this crop.

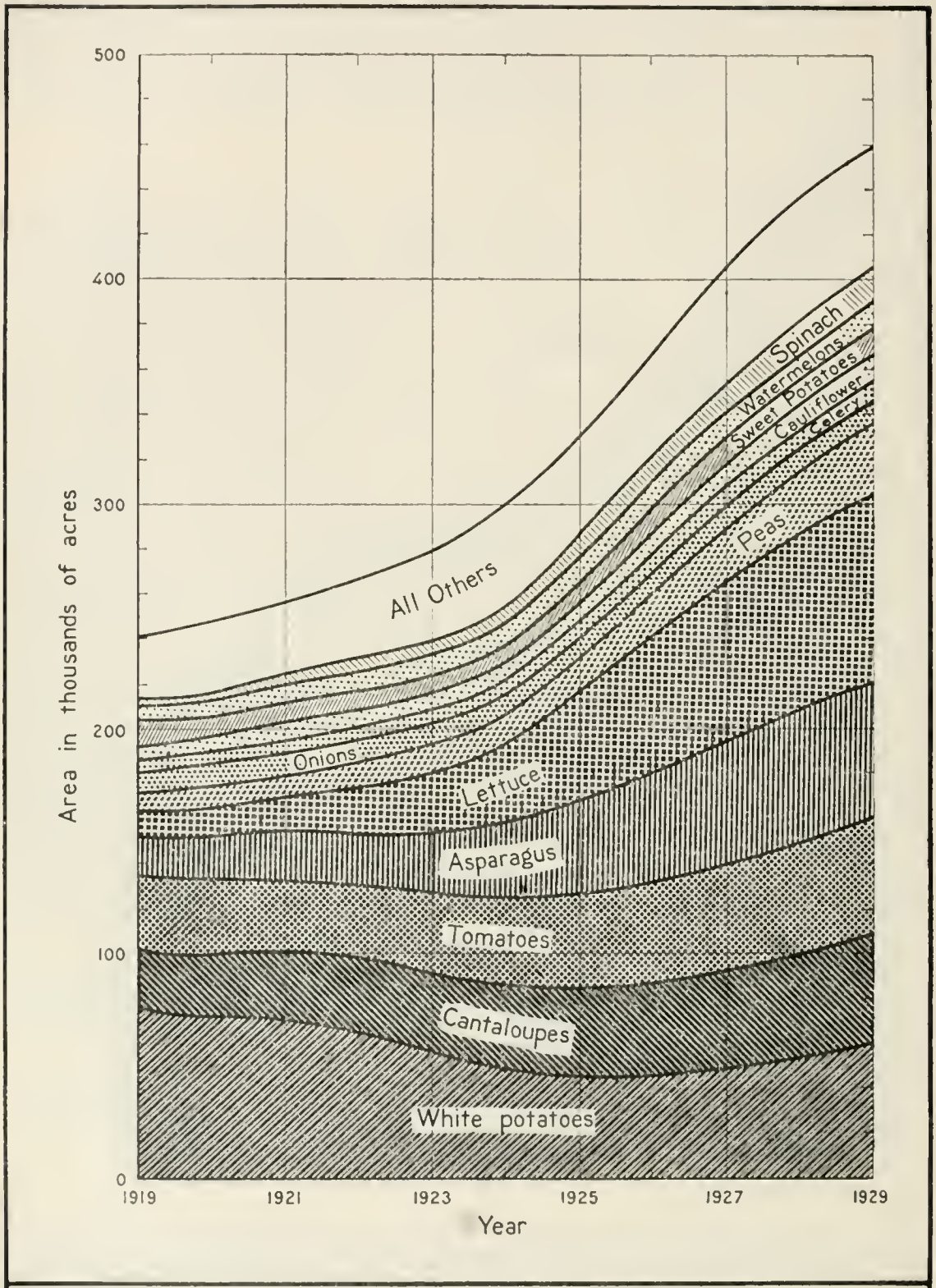
Table 19 shows the percentage increases and decreases in the trends of the acreages of these three crops for the periods 1909 to 1929, 1909 to 1919 and 1919 to 1929.

Hay and Forage Crops.

At the same time that a steady addition was being made to land in alfalfa over the 20-year period, 1909 to 1929, the acreage in grain hay, other tame hay and wild hay was rapidly falling off. The decreased acreage represented by these crops overbalanced the increased alfalfa acreage to such an extent that the total acreage decreased a little more than 20 per cent. Notwithstanding this decreased acreage the feed value of the hay crops combined was more than 50 per cent greater in 1929 than in 1909.

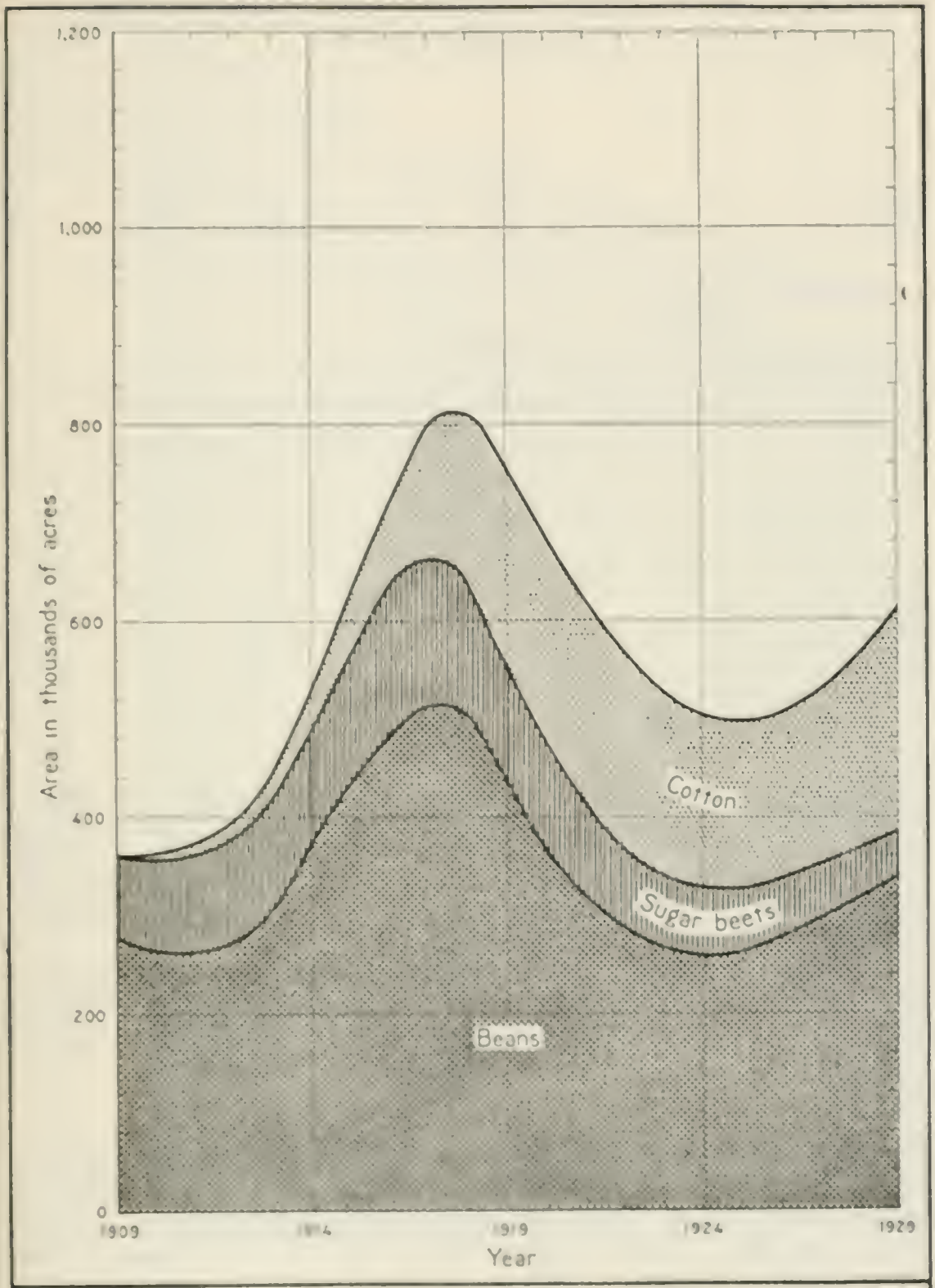
* The trends for this group follow very closely the ratio-to-trend three-year moving average. This is equivalent to a weighted five-year moving average in which the weights are 1, 2, 2, 2 and 1 for the respective years.

Plate XVII



TRENDS IN THE ACREAGES
OF
VEGETABLE CROPS HARVESTED
IN
CALIFORNIA

Plate XVIII



TRENDS IN THE COMBINED ACREAGES
OF
SUGAR BEETS, BEANS AND COTTON HARVESTED
IN
CALIFORNIA

TABLE 19

THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGES OF BEANS, SUGAR BEETS AND COTTON

Crop	Percentage increase or decrease in acreage[1]		
	1909-29	1909-19	1919-29
Beans	18	58	—25
Sugar beets	—42	48	—61
Cotton	+2,700	2,375	13

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

TABLE 20

THE RELATION OF THE CALIFORNIA ACREAGES OF THE HAY CROPS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGE OF EACH

Group and crops	Percentages of total hay crops acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Total hay crops	42	34	28	—22	—13	—10
Alfalfa	20	34	53	+107	+49	+39
Grain hay	64	51	34	—60	—32	—42
Other tame hay	6	7	5	—37	—3	—35
Wild hay	10	8	8	—40	—29	—16

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

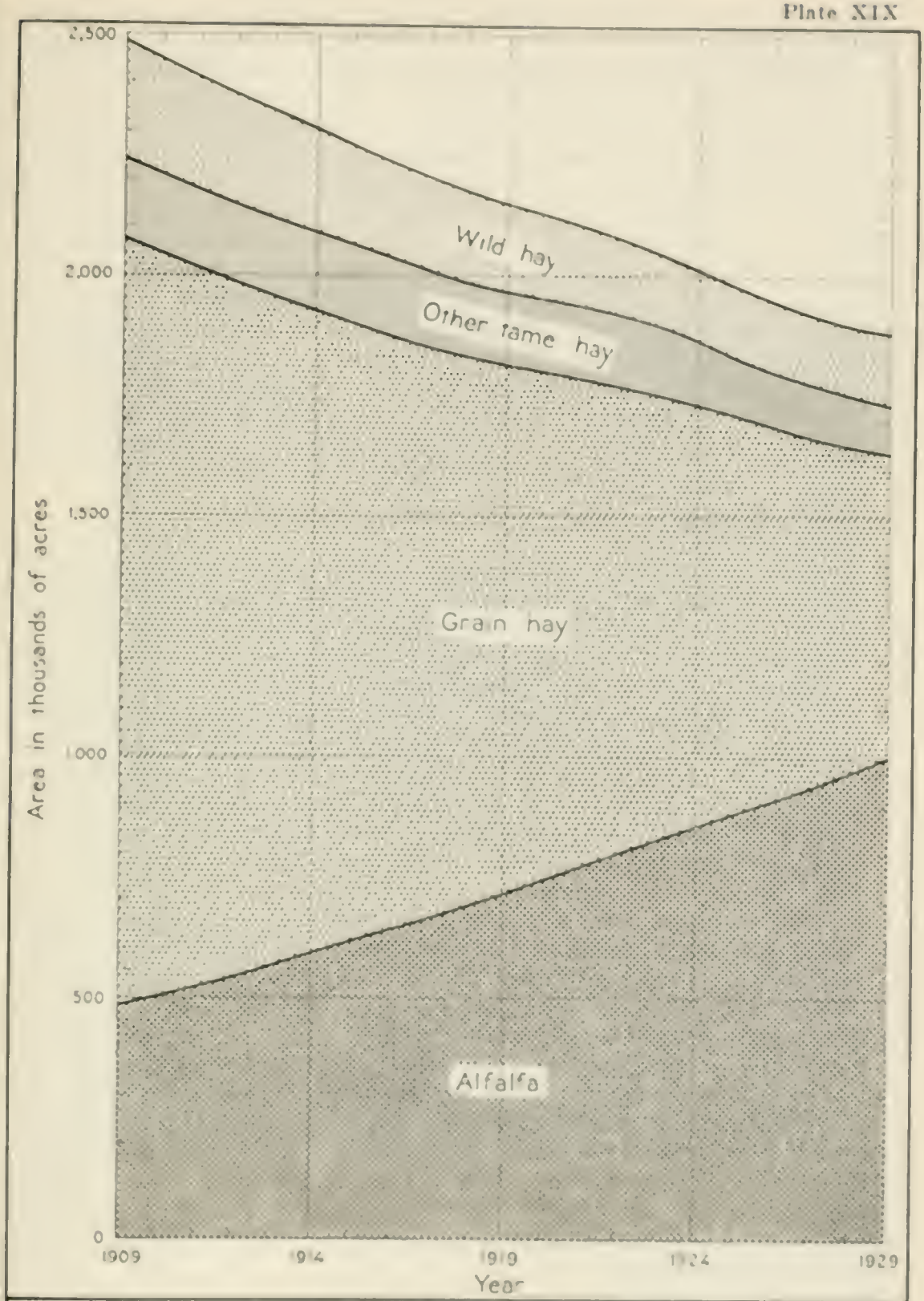
This shift from grain hay to alfalfa is shown in Table 20 and in Plate XIX. In 1909 approximately 64 per cent of the area in hay and forage crops was devoted to grain hay, while the alfalfa acreage was only about 20 per cent of the total. By 1929 the situation was almost reversed, alfalfa acreage being about 53 per cent of the total, while grain hay was only 34 per cent.

Although other tame hay and wild hay acreage decreased almost 40 per cent from 1909 to 1929, this decrease did not affect the total appreciably, inasmuch as this acreage represented only about 12 per cent of the total hay and forage acreage.

Cereals.

A little more than 2,000,000 acres, almost one-third of the total area in harvested crops, is used in the production of cereals which are harvested for grain. When fallow land is included the area is much larger than this. There has been about a 6 per cent decrease in the total acreage since 1919. Barley, the most important crop from the standpoint of acreage in this group, occupied approximately 14 per cent of the total area of crop land harvested in 1929. This crop has decreased a little more than 25 per cent in the past two decades, while wheat, the harvested area of which was nearly 700,000 acres in 1929, a little more than two-thirds that of barley, has increased its acreage about 4 per cent. Wheat, however, had undergone a precipitous decline in acreage just prior to the beginning of these two decades and barley had just reached the summit of expansion.

Plate XIX



TRENDS IN THE ACREAGES
OF
HAY AND FORAGE CROPS HARVESTED
IN
CALIFORNIA

Rice, oats, corn and the sorghum grains altogether have a harvested acreage less than that of wheat. A number of these, however, are more important from the standpoint of irrigation and some of them have much higher gross returns per acre, thus giving them a greater relative importance than their acreage would indicate. All of this group have had upward trends in their acreages except oats, which has long been an important source of horsepower but which has been forced into a secondary position by the products of the petroleum industry. In Table 21 and Plate XX it will be noticed that all of the cereal crops except wheat suffered declining acreage trends during the decade just passed. The percentage increase in the rice acreage for the earlier decade and for the 20-year period as a whole are meaningless because of the insignificance of the acreage of rice at the beginning of the period. Although the combined acreage of rice, corn, oats and the sorghum grains is small in comparison to wheat and barley, it was their increase during the past 20 years that held a probable 25 per cent decline in the cereal acreage to one of about 6 per cent.

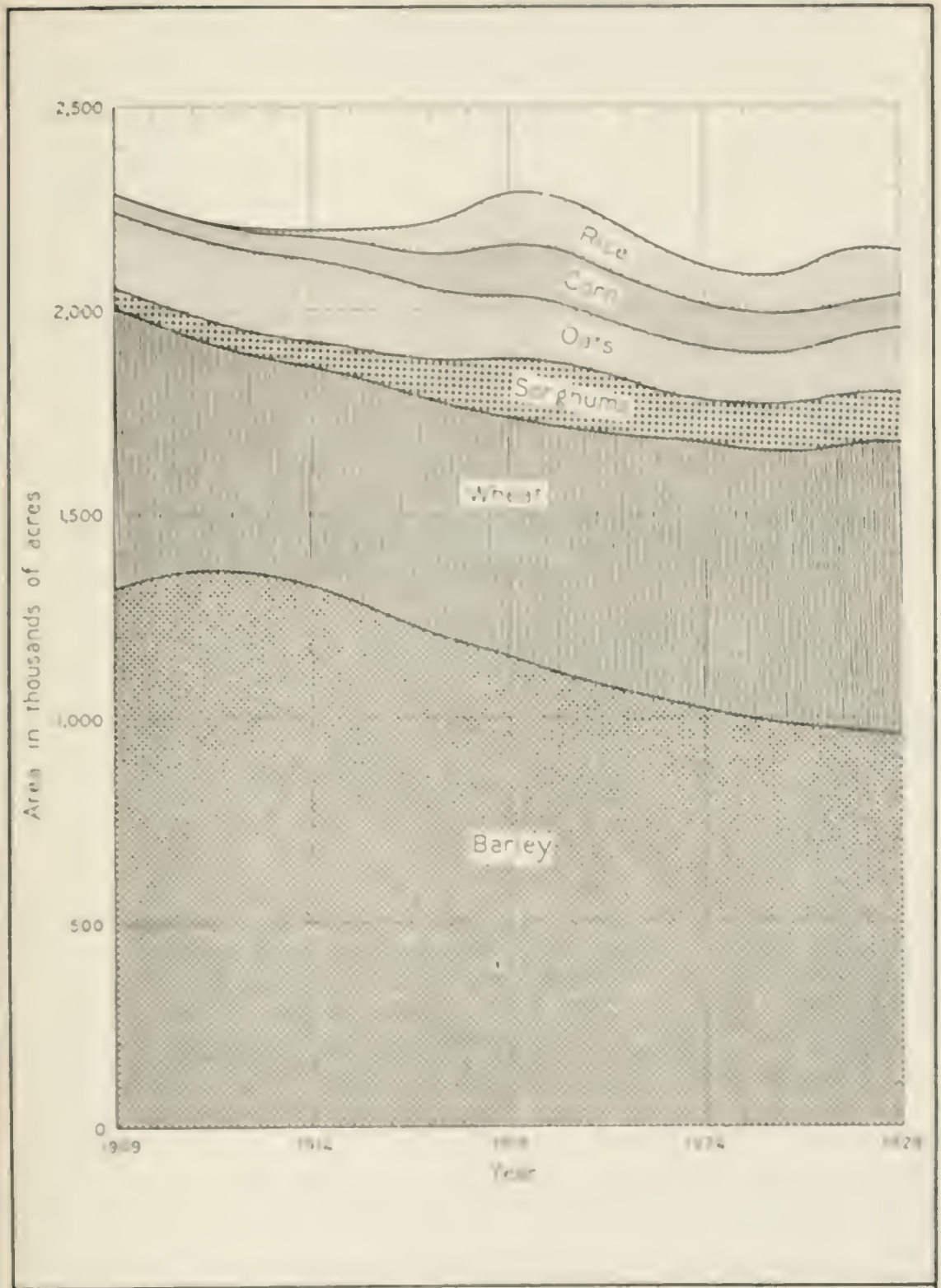
Geographical Distribution of Crop Production.

It has not been possible to include here the results of an analysis of local areas, inasmuch as the smaller the area the more difficult it becomes to obtain reliable data. An effort has been made, however, to give some attention to the relation between the trends of the acreages for the state as a whole to the changes taking place in the San Joaquin and Sacramento valleys so that a more intelligent estimate might be made of irrigated land requirements. Table 22 gives the acreages of the total crop land harvested for the state and for the two interior valleys for 1909, 1919 and 1929. It will be observed that the the relative area of crop land harvested has increased in the two valleys and decreased in the other parts of the state. In 1909 seventeen counties* of the two valleys contained 43 per cent of the total crop land harvested in the state. By 1929 this percentage had increased to 55 per cent. Total crop land harvested, however, does not tell the whole story. Subtropical fruit and nut acreage in the San Joaquin Valley increased in relative importance from 40 per cent of the state total acreage of this group of crops in 1909 to 52 per cent in 1929, while in the Sacramento Valley this group decreased in relative importance from 10 per cent in 1909 to 9 per cent in 1929. With respect to temperate zone fruits the acreage relative to the state total acreage of temperate zone fruits decreased during the two decades from 26 to 21 per cent in the San Joaquin Valley and increased from 17 to 21 per cent in the Sacramento Valley. In the other parts of the state temperate zone fruits increased in relative importance with respect to the state total from 57 per cent to 58 per cent.

The counties other than those of the interior valleys gained in the production of vegetables from 64 per cent of the state total to 72 per cent, while the counties of the Sacramento Valley increased in relative importance with respect to state vegetable acreage from 9 to 14 per cent, leaving the San Joaquin Valley with only 14 per cent of the state vegetable acreage, whereas 20 years ago the San Joaquin Valley

* Sacramento Valley counties included were Butte, Colusa, Glenn, Sacramento, Solano, Sutter, Tehama, Yolo and Yuba. San Joaquin Valley counties included were Kern, Kings, Tulare, Fresno, Madera, Merced, Stanislaus and San Joaquin.

Plate XX



TRENDS IN THE ACREAGES
OF
CEREAL CROPS HARVESTED
IN
CALIFORNIA

TABLE 21

THE RELATION OF THE CALIFORNIA ACREAGES OF THE CEREAL CROPS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGE OF EACH

Group and crop	Percentage of total cereal crop acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Cereal crops	100	100	100	—6	—2	—4
Rice	----------	6	6	11,900	13,200	—10
Corn	2	6	4	56	140	—35
Sorghum grain	2	6	5	173	220	—15
Wheat	30	25	33	4	—15	23
Barley	58	50	45	—27	—13	—17
Oats	8	7	7	—20	—14	—7

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

TABLE 22

ACREAGES OF TOTAL CROP LAND HARVESTED IN THE SAN JOAQUIN AND SACRAMENTO VALLEYS, AND IN CALIFORNIA AS A WHOLE, 1909, 1919 AND 1929

District	1909		1919		1929	
	Thousands of acres	Per cent of total	Thousands of acres	Per cent of total	Thousands of acres	Per cent of total
San Joaquin	1,692	28	1,949	31	2,384	35
Sacramento	910	15	1,178	19	1,379	20
Other	3,369	57	3,239	50	3,076	45
Totals, California	5,971	100	6,366	100	6,839	100

Computations are on basis of trends.

had 27 per cent of the area in this group of crops. The expansion of cotton acreage has given the San Joaquin Valley a much more prominent place in the production of field crops than was the case two decades ago. Most of this gain came in the past ten years.

Hay crops have gained in relative importance in the San Joaquin Valley and have lost in the Sacramento Valley. However, the increase in the San Joaquin Valley has been sufficient to reduce the relative importance of the counties other than those in the valley from 65 per cent of the state acreage in 1909 to 58 per cent in 1929. Cereals have become relatively more important in the Sacramento Valley, but have just about held their own in the San Joaquin Valley, leaving other than valley counties with a decline in relative importance of from 42 per cent to 27 per cent. It is only the vegetable crop acreage that the counties outside of the interior valleys seem to have expanded at a much more rapid rate than has been the case in the interior. These relative rates of expansion will be of importance in considering probable future trends. The foregoing figures showing the relative rates at which the different crop groups have expanded in different parts of the state emphasize the importance of a further consideration of land utilization in the Sacramento and San Joaquin valleys.

LAND UTILIZATION IN THE SAN JOAQUIN VALLEY

With the exception of a rather important development in eastern Contra Costa County and the existence of crop lands in very small portions of Alameda, Tuolumne and Mariposa counties, the agricultural area of the San Joaquin Valley is included within the boundary of eight counties. These counties are Kern, Kings, Tulare, Fresno, Madera, Merced, Stanislaus and San Joaquin. Inasmuch as census statistics fill a number of gaps in the analysis being made, and because Contra Costa County has a portion of its agricultural area lying outside of the San Joaquin Valley, it is considered best to exclude this county in the study of trends in land utilization, but to take account of its crop land area in the final conclusion to be drawn. The trends in the land utilization in these eight counties indicate very closely the changes taking place in the San Joaquin Valley as a whole.

The area in harvested crops in these eight counties of the San Joaquin Valley in 1929 was approximately 2,377,000 acres, nearly twice as large as that of the nine most important counties, agriculturally, of the Sacramento Valley. It has already been pointed out that the total crop land harvested for the state as a whole in 1929 was nearly 7,000,000 acres and that the harvested crops in the San Joaquin Valley were 35 per cent of that total.

In the San Joaquin Valley there have been the same general shifts from the small grains to fruits as is characteristic of the state as a whole. This has resulted in a more complete utilization of the improved land in farms through the reduction of the fallow land area. As a result an increase in the area of crop land harvested has been made possible notwithstanding an actual downward trend in the total area included within farms. Plate XXI illustrates this tendency. In Plate XIII attention was called to the rapid decline of the area in non-bearing fruits. In Plate XXI this same acreage is given in a much smaller scale to show more nearly its importance relative to the area in harvested crops. In Plate XXII the crop land harvested in the San Joaquin Valley, subdivided into the major groups, is shown on a much larger scale. Table 23 shows the acreages, and also the trends in the acreages, from which Plate XXII was constructed. Table 24 shows the percentage increases in the different crop groups and the relative importance of the different groups from the standpoint of acreage.

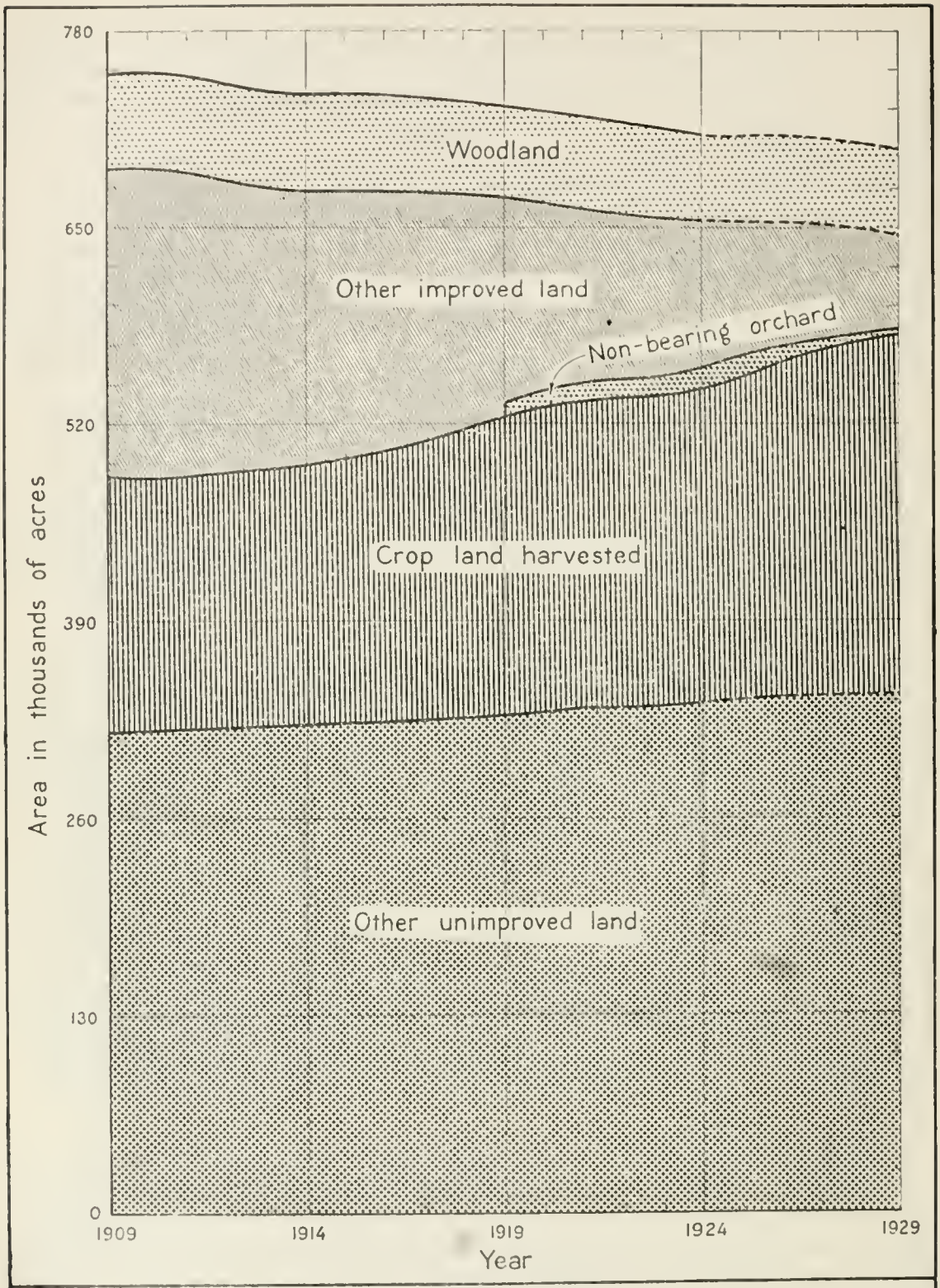
Sub-tropical Fruits and Nuts.

Most of the expansion in the crop land harvested has occurred in the fruit acreage. By 1929 approximately one-fourth of the cropped acreage in this valley was devoted to the production of sub-tropical fruits and nuts. This acreage increased over 200 per cent from 1909 to 1929, most of the expansion occurring during the last decade.

In 1929 about 78 per cent of this area was in grapes, which constituted nearly 73 per cent of the entire California grape acreage.* The San Joaquin Valley grape acreage is responsible to a large degree for the characteristics we have observed with respect to California sub-tropical fruits. By comparing Plates XV and XXIII, however, it will be seen that in the state as a whole citrus fruits and the nut crops

* The vinifera grape, which includes most California varieties, is classified by horticulturists as a sub-tropical fruit.

Plate XXI



TRENDS IN THE ACREAGES
OF
ALL LANDS IN FARMS
CLASSIFIED ACCORDING TO MAJOR USES
IN THE
SAN JOAQUIN VALLEY

TABLE 23

ACREAGES AND TRENDS IN THE ACREAGES OF THE TOTAL CROP LAND HARVESTED IN THE SAN JOAQUIN VALLEY, 1909-1929

Year	Grain		Hay and Forage		Sub-tropical fruits		Miscellaneous field crops		Temperate-zone fruits		Vegetables		Total	
	Average	Trend	Average	Trend	Average	Trend	Average	Trend	Average	Trend	Average	Trend	Average	Trend
1880	764,700	807,800	448,500	456,200	182,400	181,900	17,600	17,600	57,800	57,400	41,400	42,000	1,616,800	1,590,200
1890		710,000		280,000		189,800		30,200		68,400		42,900		1,472,200
1900		734,500		370,200		199,500		37,900		76,600		48,000		1,477,800
1905		799,200		536,600		220,700		27,100		80,900		51,600		1,664,200
1909		748,500		685,900		215,400		40,400		84,100		54,000		1,786,600
1914		743,000		760,000		200,200		30,000		69,900		50,000		1,752,200
1919		734,500		991,000		240,100		17,400		64,500		58,900		1,757,000
1920		701,500		968,200		252,000		43,700		65,700		61,900		1,792,400
1927		724,400		917,100		252,400		44,100		67,100		62,900		1,807,200
1928		698,500		924,000		254,400		44,900		66,900		64,000		1,804,200
1929	691,000	684,100	912,700	926,000	284,600	267,700	58,600	58,000	69,400	73,000	54,500	64,000	1,970,800	1,949,800
1930	980,000	940,700	971,000	993,000		325,400		45,700		78,100		60,200		1,997,000
1931	748,000	807,000	929,200	925,900		326,400		48,500		84,100		63,900		2,004,200
1932	826,000	866,300	921,600	907,200		440,200		58,900		87,200		64,300		2,064,300
1933	984,000	790,100	914,900	909,400		445,100		72,700		89,600		65,000		2,145,800
1934	670,000	698,700	911,000	905,900	404,700	400,400	80,600	108,200	106,900	107,900		64,900	1,200,000	2,005,200
1935	714,000	644,000	901,400	941,800	507,000	540,200		141,500	118,900	114,600		65,100	1,300,000	2,139,400
1936	661,000	700,400	900,000	972,100	587,400	626,100		167,700	121,600	120,400	68,200	65,900	1,184,100	2,204,600
1937	734,000	725,000	901,600	977,600	611,600	598,500		172,000	143,000	124,000	68,300	66,800	1,200,000	2,278,000
1938	748,500	742,400	902,500	984,000	522,000	569,700		210,000	130,500	125,000	70,600	67,700	1,400,000	2,208,200
1939	800,000	770,000	903,000	990,700	592,400	600,700	116,000	245,700	114,000	132,300	69,000	67,100	1,270,000	2,084,200

[1] Averages and trends have been brought to round numbers to facilitate computations.

[2] In estimating total acreages, use of averages of vegetables for the years 1924 and 1925, and of miscellaneous field crops for the years 1925-1928, was used.

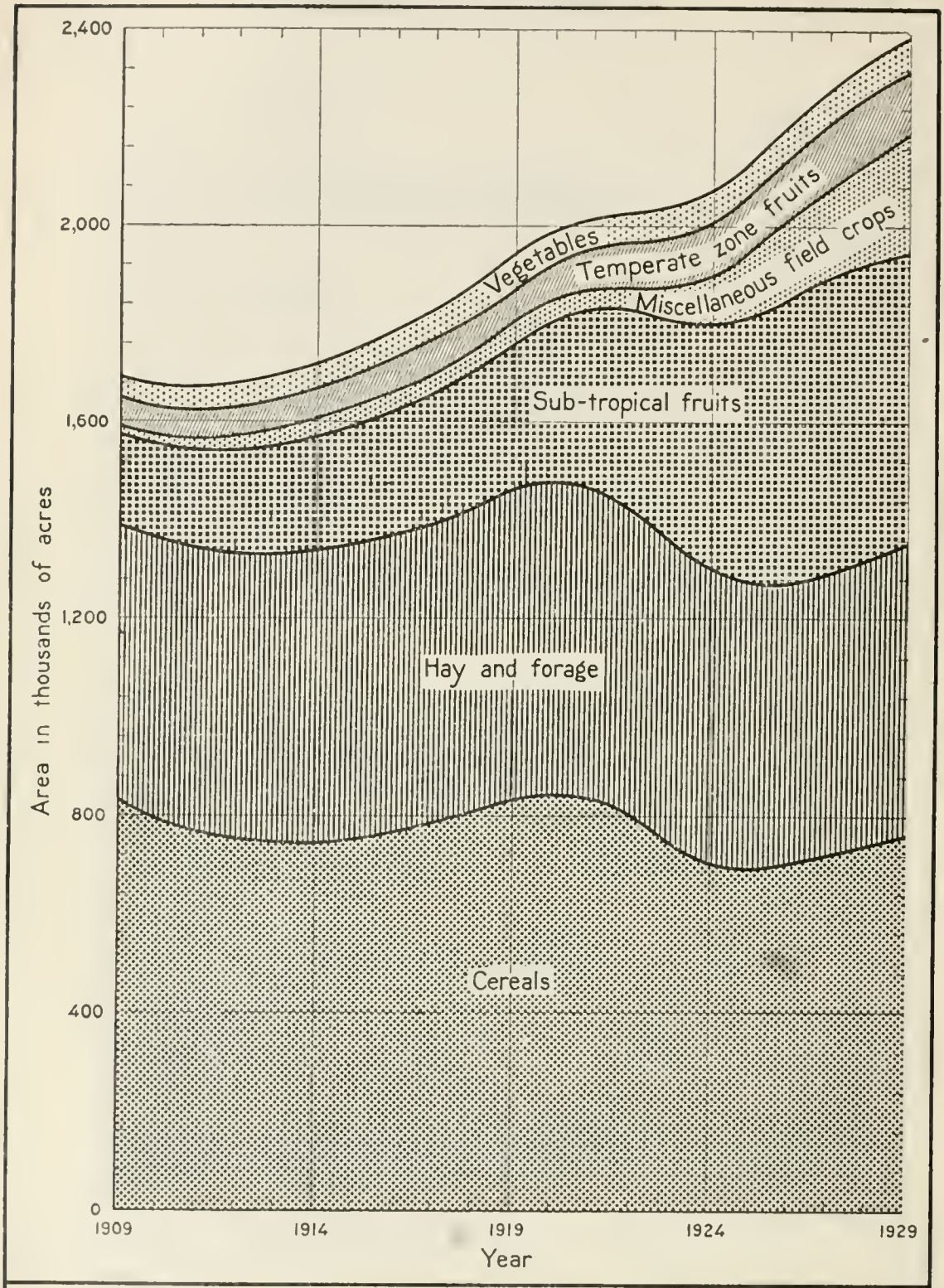
Sources of data:

1909, Dept. of Com., Bur. of Census, Census of the United States Irrigation for California, 1910, 650-655, Table 4

1910-29, data furnished by the Office of Agricultural Statistician, California Cooperative Crop Reporting Service.

[3] Trends estimated by the writer.

Plate XXII



TRENDS IN THE ACREAGES
OF THE
TOTAL CROP LAND HARVESTED
CLASSIFIED ACCORDING TO MAJOR GROUPS
IN THE
SAN JOAQUIN VALLEY

occupy a much more than important place. Grapes predominate, however, in the state totals of sub-tropical fruits, in which San Joaquin Valley grape acreage represents nearly 50 per cent.

Although of minor relative importance in comparison to grape acreage, figs, citrus fruits, nuts and olives have all made important gains, as shown in Table 25, which gives percentage increases for each of the past two decades and for the 20-year period as a whole.

TABLE 24

PERCENTAGE OF TOTAL HARVESTED CROP AREA IN THE SAN JOAQUIN VALLEY DEVOTED TO DIFFERENT GROUPS OF CROPS AND PERCENTAGE INCREASE OR DECREASE IN THE ACREAGES OF THE DIFFERENT GROUPS

Crop groups	Percentage of total crop land harvested			Percentage increase or decrease in acreage		
	1909	1919	1929	1909-29	1909-19	1919-29
Total crop land harvested	100	100	100	41	15	22
Sub-tropical fruits and nuts	11	15	23	224	61	98
Temperate zone fruits	4	4	5	118	28	71
Vegetables	3	3	3	58	51	3
Miscellaneous field crops	1	2	10	1,341	216	396
Hay and forage	33	32	25	7	13	—5
Cereals	49	42	32	—9	—0 6	—9

[illegible] indicates a decrease.
Percentages are computed on basis of [illegible]

TABLE 25

THE RELATION OF THE SAN JOAQUIN VALLEY ACREAGES OF THE INDIVIDUAL SUB-TROPICAL FRUITS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE IN THE ACREAGE OF EACH

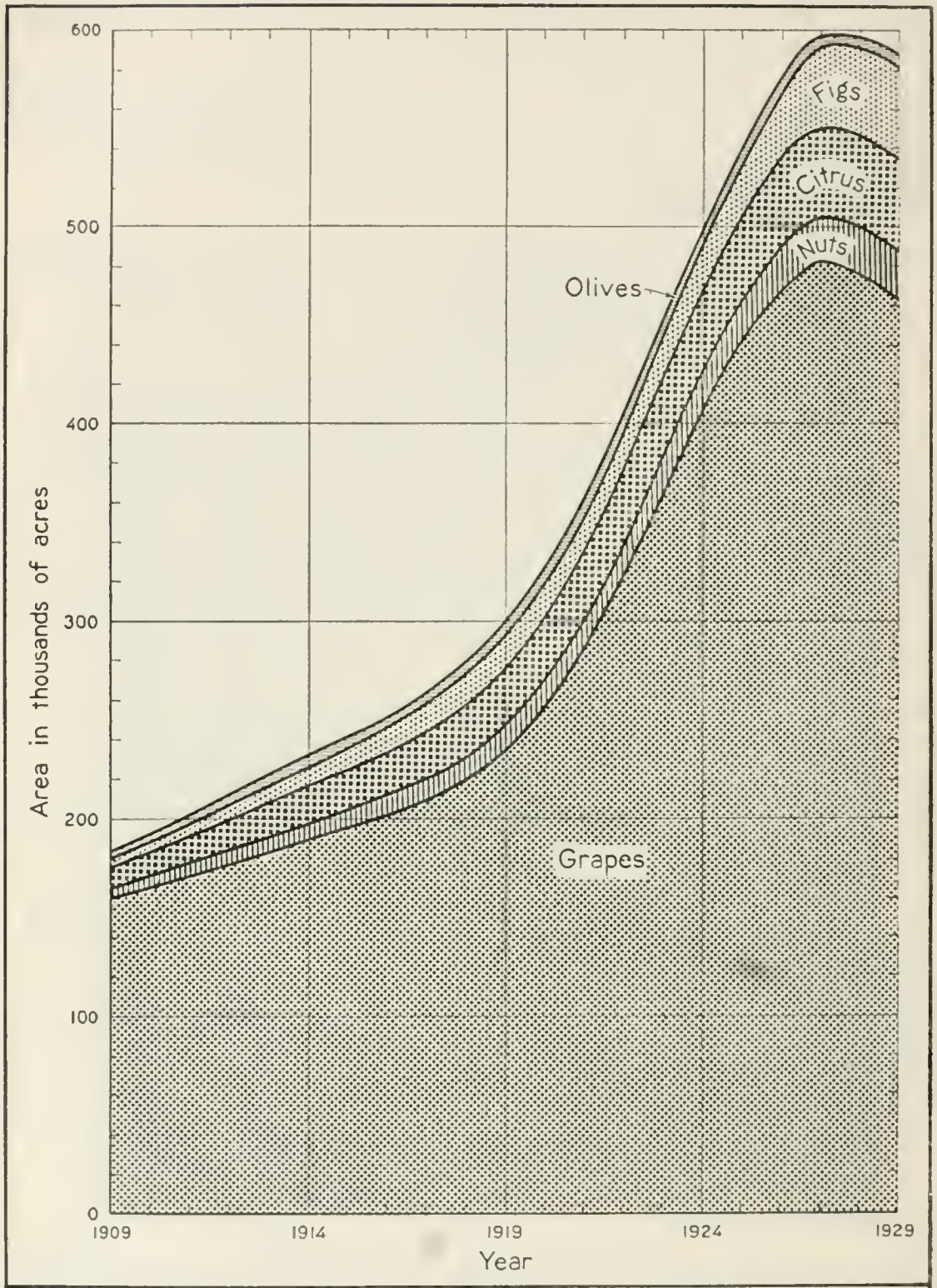
Group and crop	Percentage of total sub-tropical fruit acreage			Percentage increase in acreage		
	1909	1919	1929	1909-29	1909-19	1919-29
Sub-tropical fruits and nuts	100 0	100 0	100 0	224	64	98
Lemons	0 4	0 6	0 5	344	136	73
Oranges	5 3	8 7	7 2	297	145	43
Grapefruit	0 5	0 3	0 2	132	93	32
Walnuts	0 2	0 3	1 1	2,750	264	433
Almonds	1 5	3 5	3 6	442	253	44
Grapes	88 0	78 6	78 3	188	47	96
Olives	1 2	2 0	2 0	442	211	73
Figs	2 5	5 1	7 8	874	221	264

Percentages are computed on basis of [illegible]

Temperate Zone Fruits.

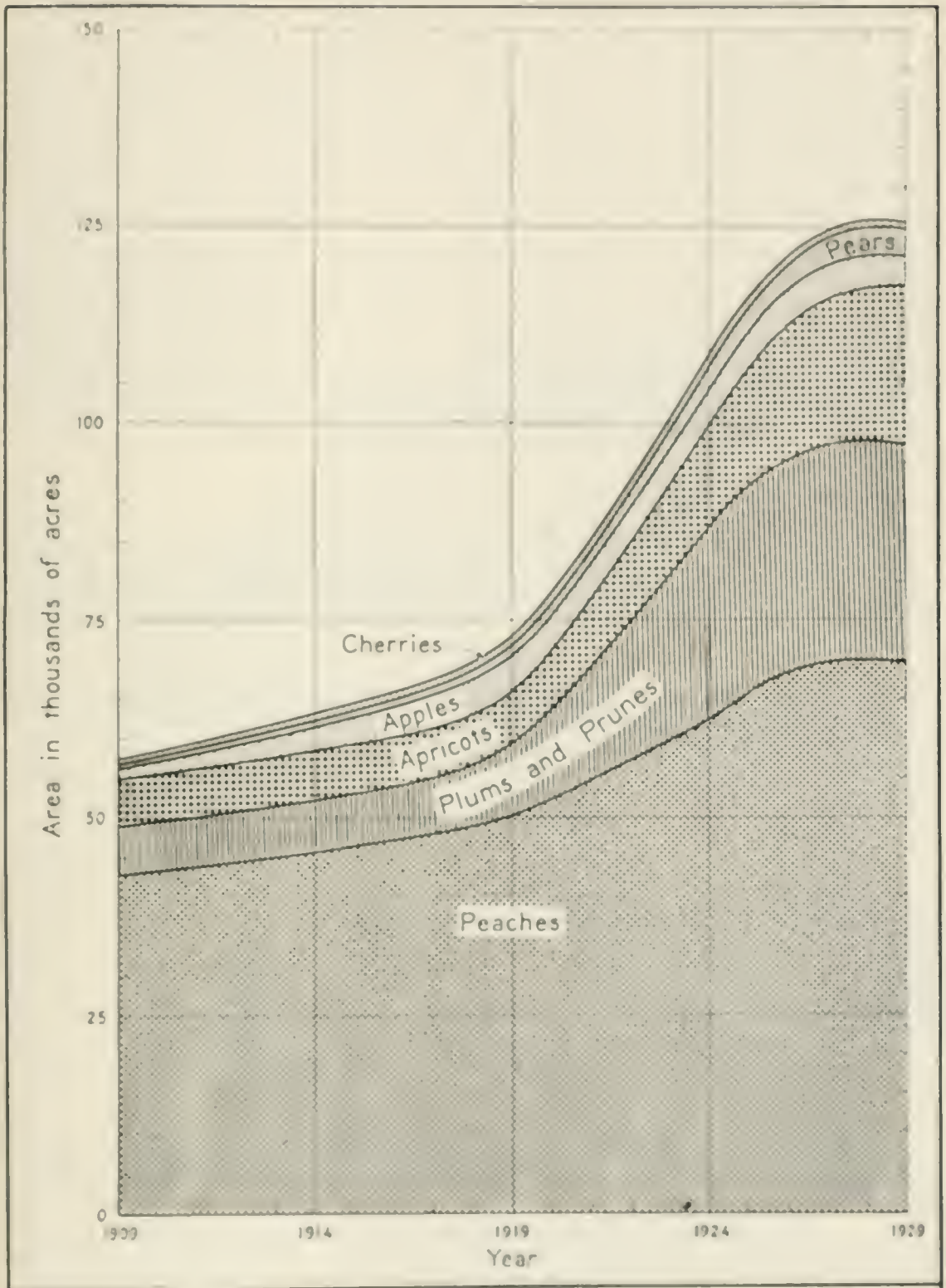
The temperate zone fruit acreage of the San Joaquin Valley increased 118 per cent from 1909 to 1929, most of the expansion coming during the past decade. Percentage increases for the important fruits of this group are given in Table 26, which, with Plate XXIV, tells how each one has contributed in more than doubling the total acreage of the group in 20 years. Peaches, plums and prunes, and apricots, just as in the state total, are the leaders in acreage; in fact in the San Joaquin Valley these crops account for 94 per cent of the temperate zone fruit acreage, while for the state as a whole the corresponding percentage was only 76.

Plate XXIII



TRENDS IN THE BEARING ACREAGES
OF THE
SUB-TROPICAL FRUITS
IN THE
SAN JOAQUIN VALLEY

Plate XXIV



TRENDS IN THE BEARING ACREAGES
OF THE
TEMPERATE ZONE FRUITS
IN THE
SAN JOAQUIN VALLEY

Sweet Potatoes, White Potatoes and Truck Crops.

It has already been stated that the relative position of the San Joaquin Valley in the production of vegetables has suffered at the expense of other areas in the state. The vegetable acreage in the San Joaquin Valley, however, has increased 56 per cent from 1909 to 1929, but that of the state increased over 200 per cent. Thus it is seen that the San Joaquin Valley did not actually have a retarded growth with respect to the vegetable crops, but that other parts of the state experienced a very exceptional expansion. This, coupled with the falling off of potato acreage in the valley, is the cause of the apparent setback. Both the sweet potato and truck crop acreages made rapid growth during this period, but the trend in the acreage of potatoes during the last decade was reduced by 22 per cent. From 1922 to 1929 the actual reduction in the potato acreage was much more extreme than this. Plate XXV and Table 27 show these trends.

Sugar Beets, Beans and Cotton.

From nothing to 250,000 acres in a little more than ten years is the record of the cotton acreage in the San Joaquin Valley. More than 80 per cent of the state cotton is now produced in these eight counties.

TABLE 26

THE RELATION OF THE SAN JOAQUIN VALLEY ACREAGE OF THE INDIVIDUAL TEMPERATE ZONE FRUITS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN ACREAGES OF EACH

Group and crop	Percentage of total temperate zone fruit acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Temperate zone fruits	100.0	100.0	100.0	118	28	71
Cherries	0.5	0.3	0.2	—6	—6	0
Pears	0.9	2.0	3.0	700	155	214
Apricots	10 0	9.0	16.0	238	15	193
Apples	3.0	6.0	3 0	145	210	—21
Peaches	74.6	69.7	55.8	62	17	38
Prunes and plums	11.0	13.0	22 0	348	58	184

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

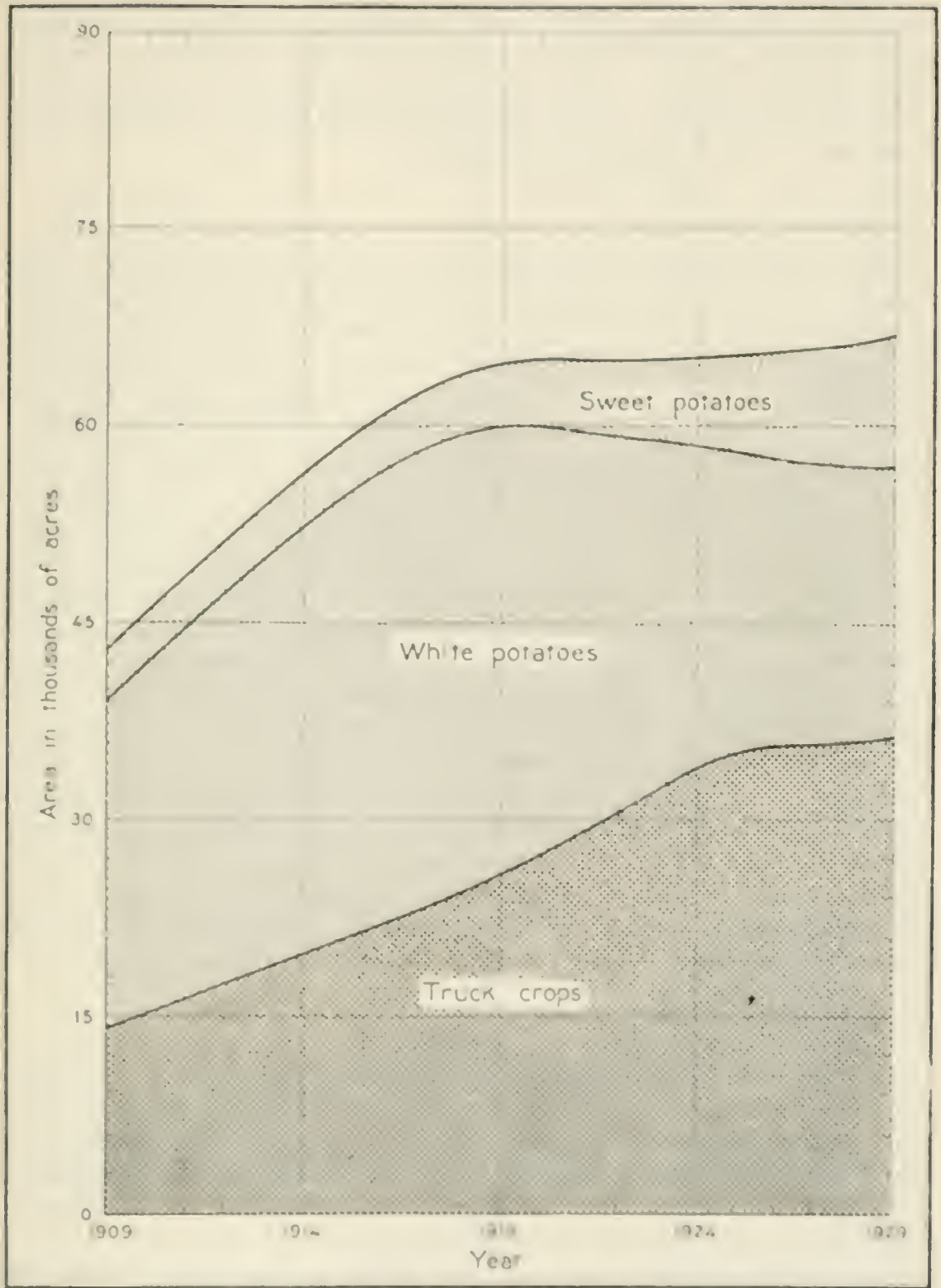
TABLE 27

THE RELATION OF THE ACREAGES OF POTATOES AND SWEET POTATOES TO THAT OF TRUCK CROPS IN THE SAN JOAQUIN VALLEY AND THE PERCENTAGE INCREASE OR DECREASE IN ACREAGE OF EACH

Group and crop	Percentage of total vegetable crop acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Potatoes and truck crops	100	100	100	56	51	3
Potatoes	58	53	31	—13	1	—22
Sweet potatoes	9	7	15	149	25	83
Truck crops other than potatoes and sweet potatoes	33	40	54	155	81	41

[1] Minus sign indicates a decrease. Percentages are computed on basis of trends.

Plate XXV



TRENDS IN THE ACREAGES
OF
SWEET POTATOES, WHITE POTATOES
AND TRUCK CROPS HARVESTED
IN THE
SAN JOAQUIN VALLEY

It is little wonder that the trends of this group of miscellaneous field crops, shown in Plate XXVI, seem so unbalanced. Even in the state totals it has been seen that the crops of this group have little in common and in the San Joaquin Valley especially the major shifts in the acreage of one have had little apparent influence on the others. All have shown increases, as will be observed in Table 28.

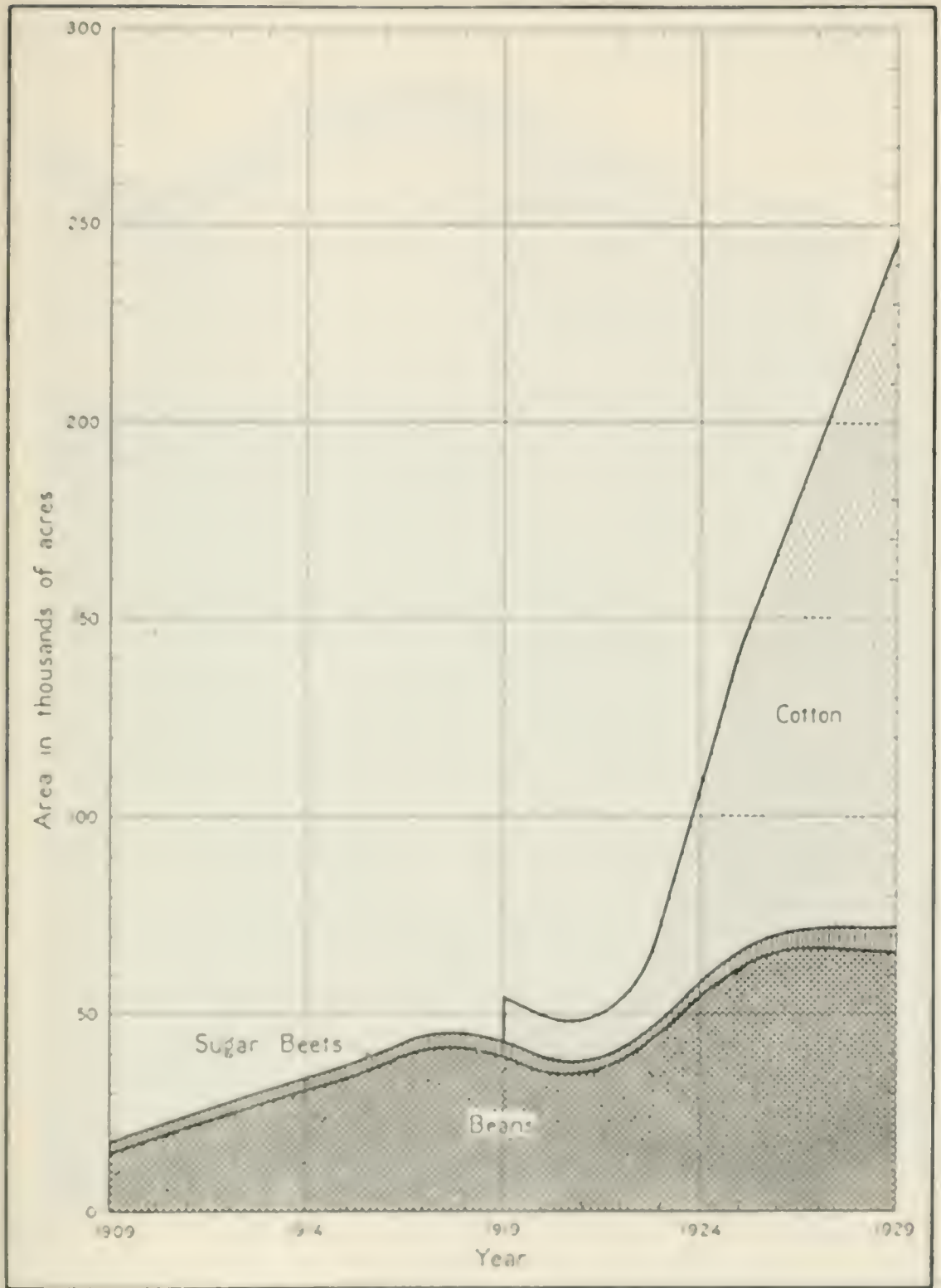
Hay Crops.

Hay crops represent an important part of the cropped acreage of the San Joaquin Valley. With the exception of minor differences, the hay crops in the San Joaquin Valley have followed the same tendencies as in the state as a whole. Expansion was more rapid than that in the state, however, from 1909 to 1919, and less rapid during the past decade. In 1929 there were nearly 623,000 acres of land devoted to the production of hay and forage crops, about one-third of the state total. Although the trend of the total hay and forage acreage increased 7 per cent from 1909 to 1929, the acreage of all the crops in this group with the exception of alfalfa decreased. Grain hay acreage, which constituted in 1929 about 23 per cent of the hay acreage, decreased 49 per cent during this period, while other tame hay and wild hay decreased their acreage by 35 and 80 per cent, respectively. During this same period, the acreage in alfalfa had been added to greatly, especially from 1909 to 1919, when an 84 per cent increase was made to the acreage. The rate of increase in the alfalfa acreage is rapidly falling off at the present, as will be seen in Plate XXVII, and also in Table 29, which shows that the increase in the trend of the acreage during the past ten years has been only 1 per cent, while the state's alfalfa acreage during this decade has expanded 39 per cent. But the rapid growth during the previous decade has resulted in the San Joaquin Valley having nearly half of the state's alfalfa acreage.

Cereal Crops.

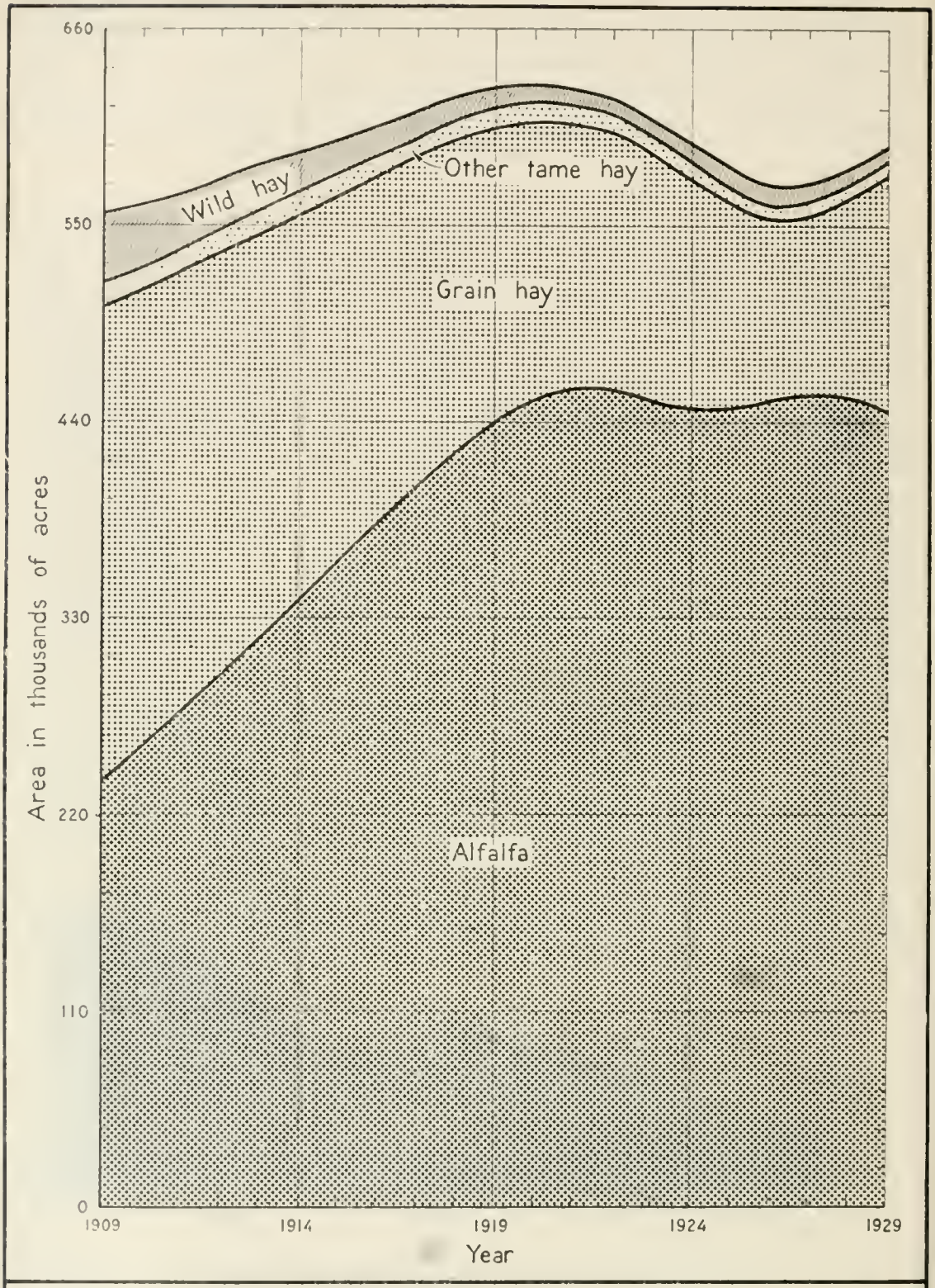
Although the cereal crops in the San Joaquin Valley occupy a greater portion of the cropped area than any other crop group, their acreage has been diminishing during the past 20 years. In 1909, 49 per cent of the cropped area in the San Joaquin Valley was devoted to the production of cereal crops, but by 1929 this area has been reduced until it constituted only 32 per cent of the total cropped area. As will be seen in Table 30, most of the decrease in the cereal acreage came during the period 1919 to 1929. Barley, which is still the most important cereal, contributed most to this decline. During this period its acreage fell 26 per cent. Although the acreage in oats has changed but little during the past ten years, during the period 1909 to 1919 the acreage of this crop was about cut in half. While the acreage of barley and oats has been decreasing, the wheat acreage has expanded until it occupied 40 per cent of the total cereal acreage in the valley in 1929. Plate XXVIII illustrates these trends graphically.

Plate XXVI



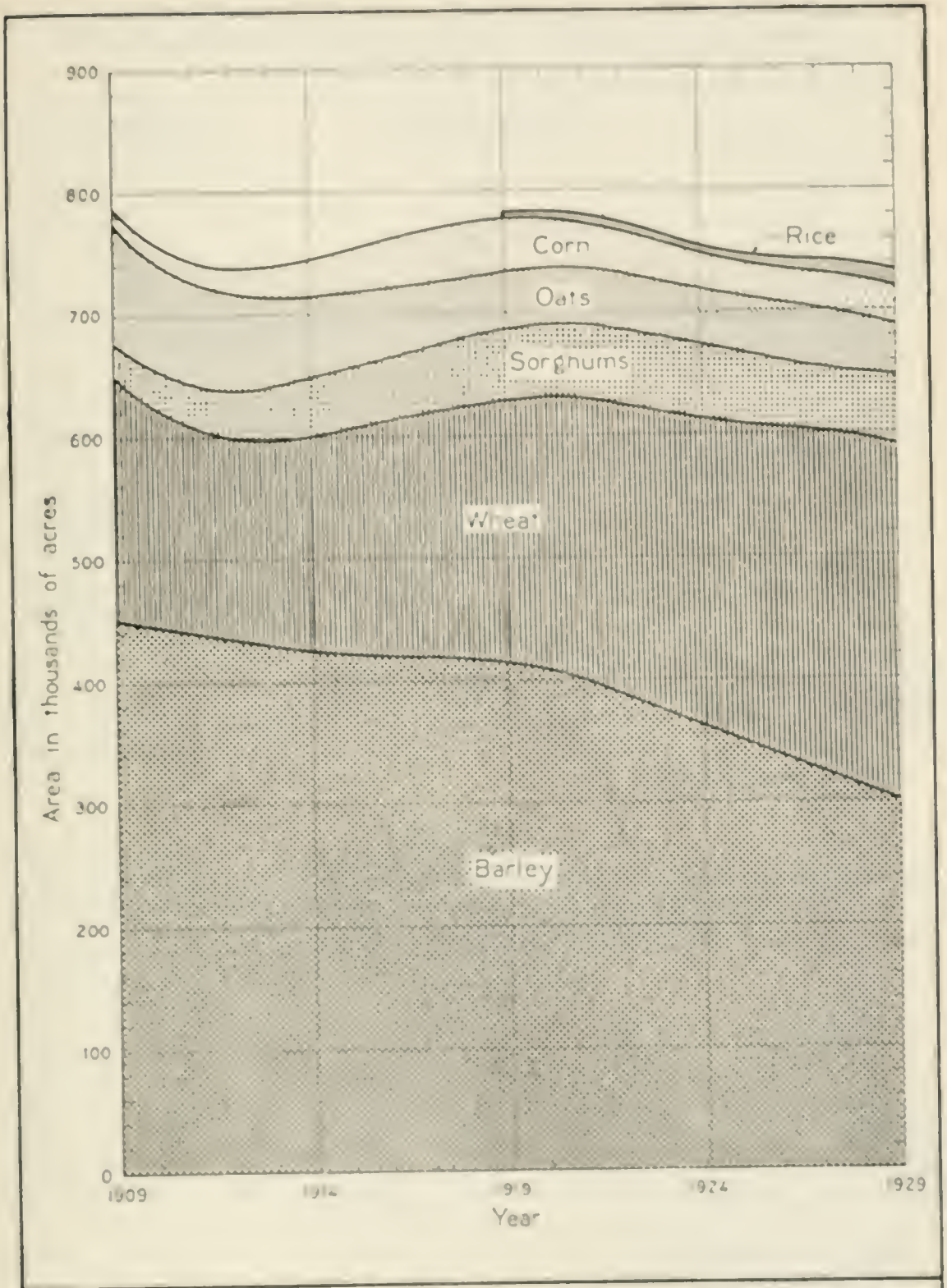
TRENDS IN THE COMBINED ACREAGES
OF
SUGAR BEETS, BEANS AND COTTON HARVESTED
IN THE
SAN JOAQUIN VALLEY

Plate XXVII



TRENDS IN THE ACREAGES
OF
HAY AND FORAGE CROPS HARVESTED
IN THE
SAN JOAQUIN VALLEY

Plate XXVIII



TRENDS IN THE ACREAGES
OF
CEREAL CROPS HARVESTED
IN THE
SAN JOAQUIN VALLEY

TABLE 28

THE RELATION OF THE SAN JOAQUIN VALLEY ACREAGE OF THE MISCELLANEOUS FIELD CROPS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE IN THE ACREAGES OF EACH

Group and crop	Percentage of total miscellaneous field crop acreage			Percentage increase in acreage		
	1909	1919	1929	1909-29	1909-19	1919-29
Miscellaneous field crops	100	100	100	1,341	216	356
Sugar beets	12	5	2	180	35	107
Beans	88	75	27	340	168	64
Cotton	----------	20	71	----------	----------	1,482

Percentages are computed on basis of trends.

TABLE 29

THE RELATION OF THE SAN JOAQUIN VALLEY ACREAGE OF THE HAY AND FORAGE CROPS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGES OF EACH

Group and crop	Percentage of total hay and forage crops acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Hay and forage crops	100	100	100	7	13	—5
Alfalfa	43	70	75	86	84	1
Grain hay	48	26	23	—49	—37	—18
Other tame hay	2	2	1	—35	—26	—12
Wild hay	7	2	1	—80	—70	—34

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

TABLE 30

THE RELATION OF THE SAN JOAQUIN VALLEY ACREAGE OF THE CEREAL CROPS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGES OF EACH

Group and crop	Percentage of total cereal crop acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Cereal crops	100	100	100	—9	—1	—9
Corn	1.4	6.1	4.1	159	322	—38
Sorghums	3.5	8.3	7.6	98	135	—16
Wheat	29.6	29.2	39.5	21	—2	23
Barley	54.1	50.5	41.2	—31	—8	—26
Oats	11.4	5.3	5.9	—52	—54	2
Rice	----------	.6	1.7	----------	----------	140

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

LAND UTILIZATION IN THE SACRAMENTO VALLEY

Although covering a relatively small part of the gross area of the state, the Sacramento Valley had within its boundaries in 1929, 20 per cent of the total crop land harvested. The greatest portion of this crop land is devoted to the production of cereals, as will be seen in Table 31 and Plate XXIX. The acreage in hay and forage crops was of great importance in 1909, when it occupied 35 per cent of the total

crop land harvested in the Sacramento Valley, but by 1929 much of this land was utilized in the production of other crops and only 15 per cent of the total crop land harvested was devoted to hay and forage crops. During this same period, the acreage in fruits, vegetables, miscellaneous field crops and cereals expanded considerably. The extent of this expansion is shown in Table 32. These percentages and the acreages mentioned in this section apply to the nine counties* comprising the major portion of the Sacramento Valley floor.

Sub-tropical Fruits.

Although the acreage in sub-tropical fruits in the Sacramento Valley nearly doubled during the period 1909 to 1929, this increase was not so great as that in the state as a whole. More than three-fourths of the area in this group of fruits is in almonds and grapes. In 1929 there were approximately 41,000 acres of grapes, which represents only about 6 per cent of the state's acreage, produced in this valley. The grape acreage increased only 43 per cent during the past decade, after having decreased 15 per cent from 1909 to 1919, as shown in Table 33. This table and Plate XXX show the increases in all of the important crops of this group. The almond acreage in the Sacramento Valley has been increasing rapidly. From 1909 to 1929, the area in almonds increased over 300 per cent, until it occupied in 1929 nearly 36,000 acres, or 39 per cent of the state's acreage. In 1929 a little over a third of the state's olive acreage was in the Sacramento Valley. This acreage has increased 342 per cent since 1909.

Temperate Zone Fruits.

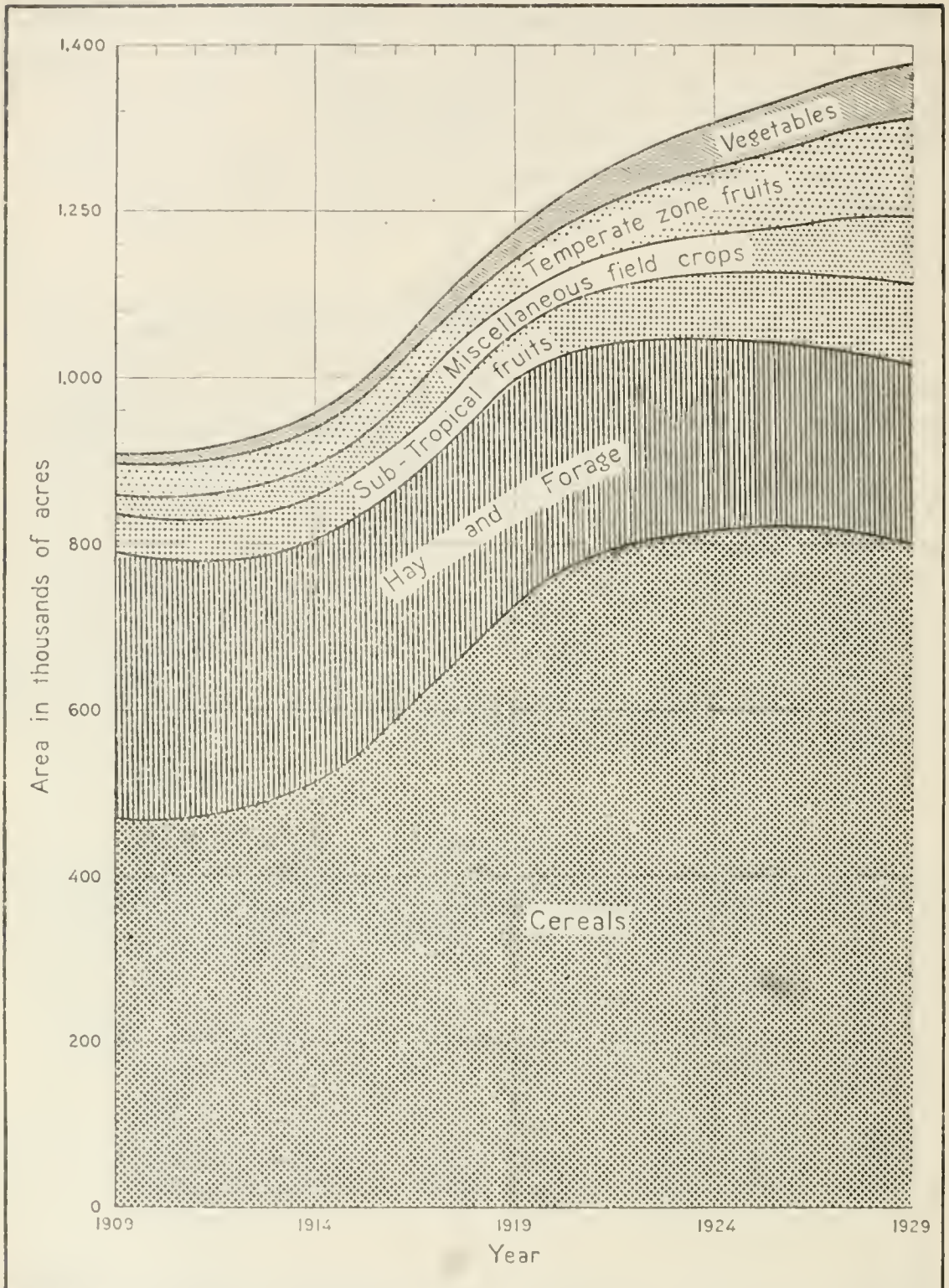
The acreage devoted to the temperate zone fruits in the Sacramento Valley expanded nearly 200 per cent during the past 20 years. Of these fruits, plums and prunes are of greatest importance, occupying 56 per cent of the 1929 prune acreage in the state. Plums and prunes have increased in acreage more than 300 per cent in the past 20 years. Next in importance is the peach acreage, which made more than a 200 per cent gain during the same period. The Sacramento Valley has about one-third of the total peach acreage of the state. It will be seen from Table 34 and Plate XXXI that most of the expansion in the acreage of temperate zone fruits, with the exception of the apple acreage, has come during the past decade. The apple acreage decreased 8 per cent during this period, but this is only a small part of the total. It is interesting to note also that during the decade 1909 to 1919 the acreage in apricots was reduced by 24 per cent, but during the past decade this industry was stimulated again and the acreage more than doubled.

Vegetables.

The greatest rate of increase in the acreage of crops in the Sacramento Valley occurred in the vegetable acreage. This acreage increased during the past 20 years more than 400 per cent, as will be seen in

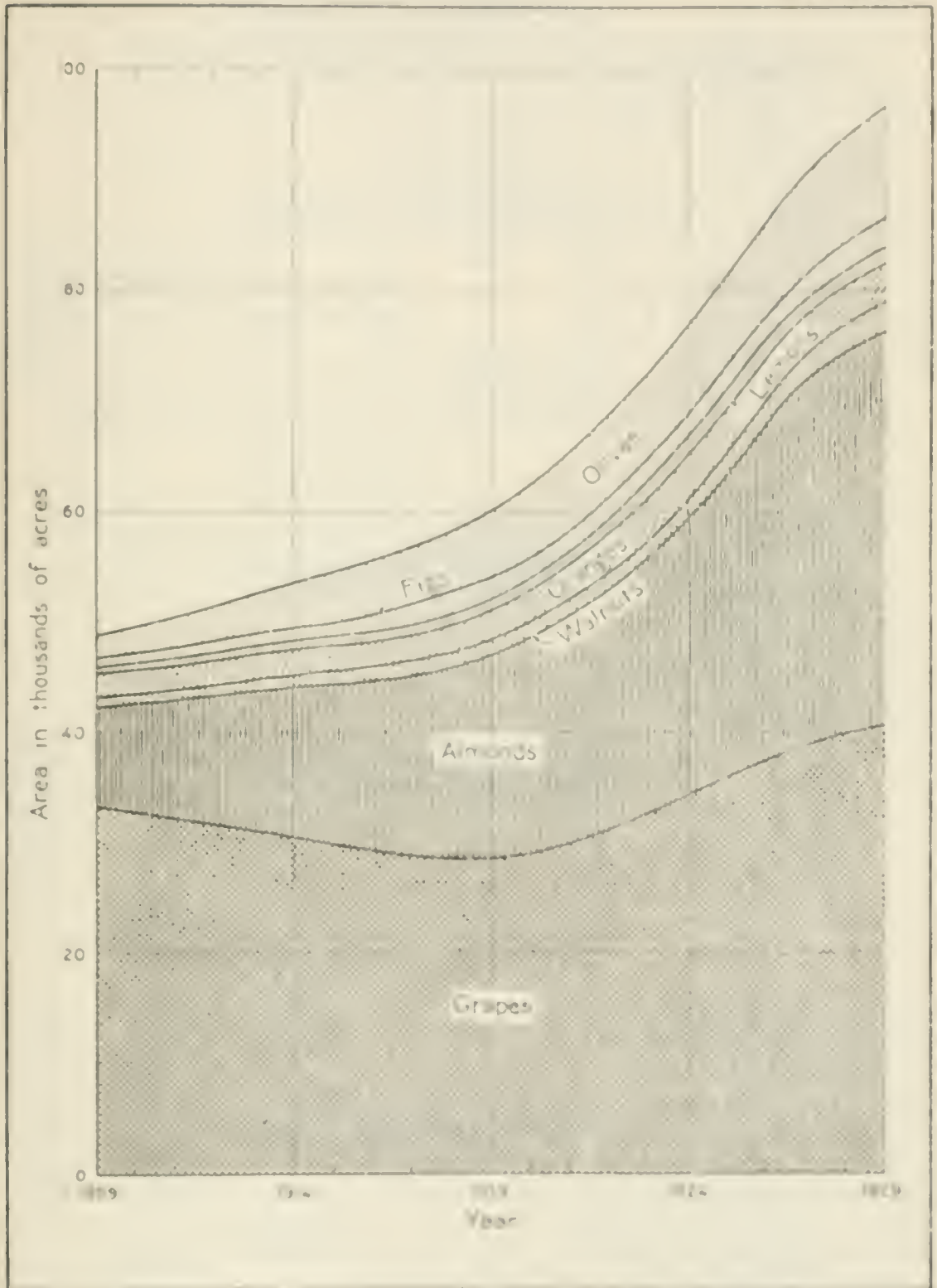
* These counties are Butte, Colusa, Glenn, Sacramento, Solano, Sutter, Tehama, Yolo and Yuba. Shasta County has some important agricultural areas, but was excluded because of difficulty of completing the 1929 data.

Plate XXIX



TRENDS IN THE ACREAGES
OF THE
TOTAL CROP LAND HARVESTED
CLASSIFIED ACCORDING TO MAJOR GROUPS
IN THE
SACRAMENTO VALLEY

Plate XXX



TRENDS IN THE BEARING ACREAGES
OF
SUB-TROPICAL FRUITS
IN THE
SACRAMENTO VALLEY

TABLE 31

ACREAGES AND TRENDS IN THE ACREAGES OF THE TOTAL CROP LAND HARVESTED IN THE SACRAMENTO VALLEY, 1909-1929

Year	Sub tropical fruits		Temperate zone fruits		Vegetables		Miscellaneous Field crops		Hay and forage		Cereals		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	48,901	48,901	36,842	36,842	12,928	12,900	24,076	24,000	319,011	318,800	447,734	468,544		909,987
1910		49,627		37,400		14,300		27,700		313,700		467,600		910,327
1911		50,702		38,000		15,900		31,800		307,400		471,600		915,402
1912		51,672		38,725		17,500		35,250		301,800		480,300		925,247
1913		52,835		39,500		19,075		38,900		296,300		494,500		941,110
1914		53,890		40,400		20,675		42,800		290,900		516,700		965,365
1915		51,920		41,150		22,260		46,700		285,600		541,225		994,855
1916		55,986		42,200		23,850		51,350		279,300		583,300		1,035,986
1917		57,086		43,025		25,450		53,500		275,300		631,800		1,086,161
1918		58,441		44,450		27,000		52,600		268,300		683,100		1,133,891
1919		60,230		47,973	27,696	30,025	61,575	48,800	262,813	265,500	902,500	725,400		1,177,928
1920		62,725		53,645		34,025		42,600	262,500	257,700	855,600	757,700		1,208,395
1921		65,610		61,200		38,975		42,050	258,400	250,500	772,400	781,000		1,239,335
1922		68,725		69,375		43,700		44,300	246,500	243,000	760,800	797,100		1,266,200
1923		72,325		77,250		48,150		46,850	231,600	236,600	740,900	805,100		1,286,275
1924	75,159	76,547	86,467	84,450		52,600	40,900	47,600	242,300	229,800	704,900	811,000		1,301,997
1925	83,360	81,319	89,924	90,100		56,625		54,050	207,200	224,400	836,100	814,350		1,320,844
1926	88,558	86,602	95,441	96,219	61,965	60,500		61,000	218,400	218,000	860,700	814,900		1,337,221
1927	90,185	91,417	103,179	103,710	62,869	62,650		69,450	213,200	213,700	845,500	809,500		1,350,427
1928	95,727	94,361	114,372	111,637	62,269	64,250		78,309	215,500	211,900	840,000	808,000		1,368,448
1929	97,509	96,659	119,896	118,170	66,961	65,250		84,600	221,000	213,000	823,500	801,200		1,378,879

Sources of data:

1909, Dept. of Com., Bur. of Cen., Census of the U. S. Statistics for California, 1910: 650-655. Table 4.
1919-1929, data furnished by office of Agricultural Statistician, California Cooperative Crop Reporting Service.
Trends computed by the writer.

TABLE 32

PERCENTAGE OF TOTAL HARVESTED CROP AREA IN THE SACRAMENTO VALLEY DEVOTED TO DIFFERENT GROUPS OF CROPS AND PERCENTAGE INCREASE OR DECREASE IN THE ACREAGE OF EACH GROUP

Crop group	Percentage of total acreage of crop land harvested			Percentage increase or decrease in acreage		
	1909	1919	1929	1909-29	1909-19	1919-29
Total harvested crop acreage	100	100	100	42	29	17
Sub-tropical fruits and nuts	5	5	7	98	23	80
Temperate zone fruits	4	4	3	251	50	146
Vegetables	1	3	5	448	183	117
Miscellaneous field crops	3	4	6	252	109	73
Hay and forage	35	28	18	−23	−17	−20
Cereals	52	61	58	71	55	10

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

TABLE 33

THE RELATION OF THE SACRAMENTO VALLEY ACREAGES OF THE INDIVIDUAL SUB-TROPICAL FRUITS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGE OF EACH

Group and item	Percentage of total sub-tropical fruit acreage			Percentage increase or decrease in acreage		
	1909	1919	1929	1909-29	1909-19	1919-29
Sub-tropical fruits and nuts	100 00	100 00	100 00	98	23	60
Lemons	57	1 07	87	852	650	51
Oranges	4 60	4 48	4 79	47	10	70
Grapefruit	02	02	09	700	20	617
Walnuts	80	2 04	2 58	565	187	70
Almonds	18 25	31 76	42 15	901	196	82
Olives	68 80	47 80	41 52	32	−15	43
Figs	4 72	13 71	10 77	242	171	81
Dates	2 00	2 00	2 08	104	82	40

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

Table 35. Plate XXXII also shows this phenomenal growth and suggests why the Sacramento Valley gained in the importance of vegetable production relative to state totals, while the San Joaquin Valley, as we have pointed out, did not make such a spectacular development. Although potato acreage declined in the Sacramento Valley, the ratio of potato acreage to the total for this group was small. Truck crop increase therefore controlled the increase for the group. Potatoes, often classified as a field crop, but which are included in this group for reasons previously given, have become relatively unimportant during the past few years, having been reduced in acreage from 3200 acres in 1909 to 1500 acres in 1929, while the area in truck crops, on the other hand, increased from 9700 acres to 65,500 acres during the same period. Sweet potato production in the Sacramento Valley has occupied a relatively unimportant place.

Miscellaneous Field Crops.

The acreage in the three crops, sugar beets, cotton and beans, increased 252 per cent from 1909 to 1929. Beets during the past decade have come into prominence in the Sacramento Valley. Although there

TABLE 34

THE RELATION OF THE SACRAMENTO VALLEY ACREAGES OF THE INDIVIDUAL TEMPERATE ZONE FRUITS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGE OF EACH

Group and crop	Percentage of total temperate zone fruit acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Temperate zone fruits	100	100	100	193	30	146
Cherries	2	3	2	172	94	41
Pears	13	15	15	272	51	147
Apricots	17	10	8	60	—24	111
Apples	3	3	1	17	27	—8
Peaches	34	30	33	218	15	176
Plums and prunes	31	39	41	315	63	154

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

TABLE 35

THE RELATION OF THE ACREAGE OF POTATOES TO THAT OF TRUCK CROPS IN THE SACRAMENTO VALLEY AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGE OF EACH

Group and crop	Percentage of total potato and truck crop acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Potatoes and truck crops	100	100	100	406	133	117
Potatoes	25	13	3	—45	26	—57
Truck crops	75	87	97	554	168	144

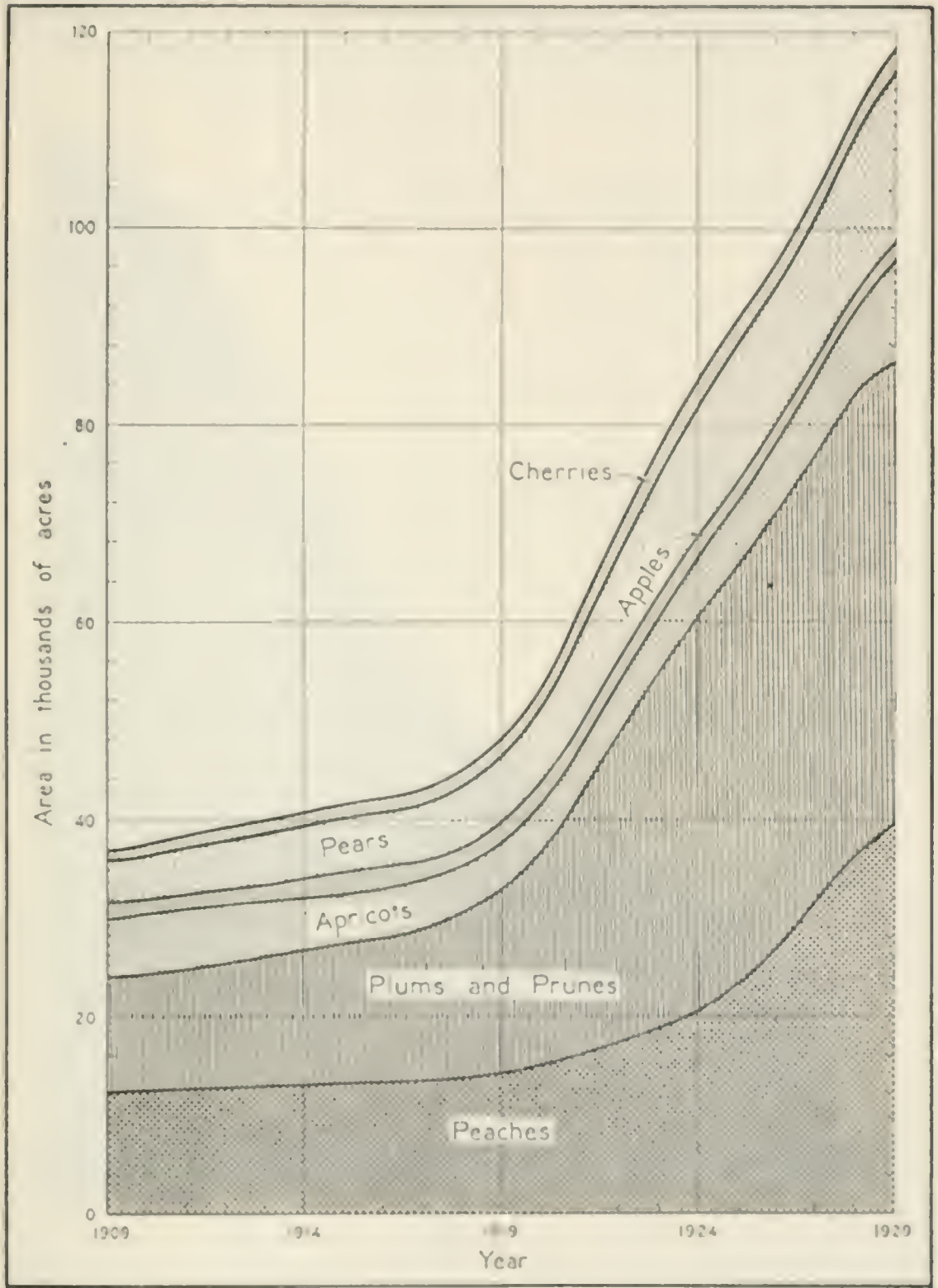
[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

was a loss of 65 per cent in the acreage from 1909 to 1919, in the following ten years the acreage expanded 1042 per cent. During the period 1909 to 1919, when sugar beets showed a decreased acreage in the Sacramento Valley, the acreage in the state increased. The bean acreage followed the same trend as the state as a whole during the past 20 years. In the first ten years, the acreage increased rapidly, as is shown in Table 36 and Plate XXXIII, only to fall from 59,950 acres in 1919 to 27,800 acres in 1924. From that time on, however, the acreage has been gaining and in 1929 45,000 acres of beans were produced in these counties. The cotton acreage in the Sacramento Valley has not yet reached a significant figure, but this small acreage is being added to yearly. In 1925, when the first cotton acreage statistics were recorded, there were 2800 acres. In 1929 the area in this crop amounted to 7600 acres, but this is negligible when compared with the California total of 309,000 acres for that year.

Hay Crops.

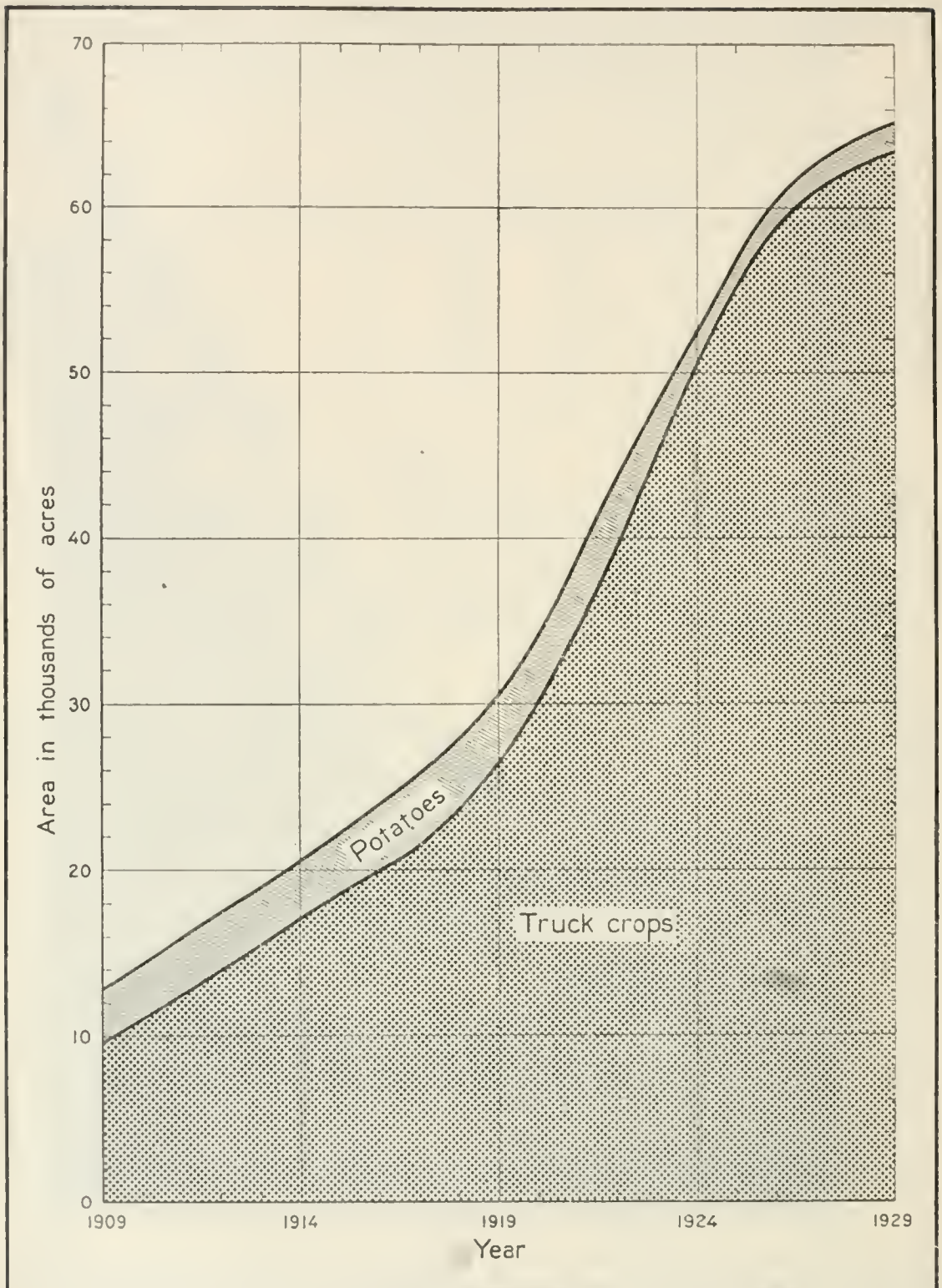
A most significant change has occurred in the hay and forage acreage in the Sacramento Valley. This is the shift observed in the case of the state acreages and those of the San Joaquin Valley, from the production of grain hay to that of alfalfa. Plate XXXIV shows this trend in the Sacramento Valley. From 1909 to 1929, the percentage of total hay acreage in alfalfa increased from 18 per cent to 61 per cent, while the

PLATE XXXI



TRENDS IN THE ACREAGES
OF THE
TEMPERATE ZONE FRUITS
IN THE
SACRAMENTO VALLEY

Plate XXXII



TRENDS IN THE ACREAGES
OF
POTATOES AND TRUCK CROPS HARVESTED
IN THE
SACRAMENTO VALLEY

TABLE 36

THE RELATION OF THE SACRAMENTO VALLEY ACREAGES OF THE MISCELLANEOUS FIELD CROPS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGE OF EACH

Group and crop	Percentage of total land in miscellaneous field crops			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Miscellaneous field crops	100	100	100	202	103	73
Sugar beets	28	8	38	868	—65	1,042
Cotton			1			
Beans	67	94	57	179	189	—2

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

TABLE 37

THE RELATION OF THE SACRAMENTO VALLEY ACREAGE OF THE HAY AND FORAGE CROPS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGES OF EACH

Group and crop	Percentage of total hay and forage crops acreage			Percentage increase or decrease in acreage		
	1909	1919	1929	1909-29	1909-19	1919-29
Hay and forage crops	100	100	100	—33	—17	—20
Alfalfa	15	47	61	128	84	24
Grain hay	70	51	30	—72	—40	—53
Other tame hay	9	4	5	47	—38	18
Wild hay	6	5	4	—53	—32	—31

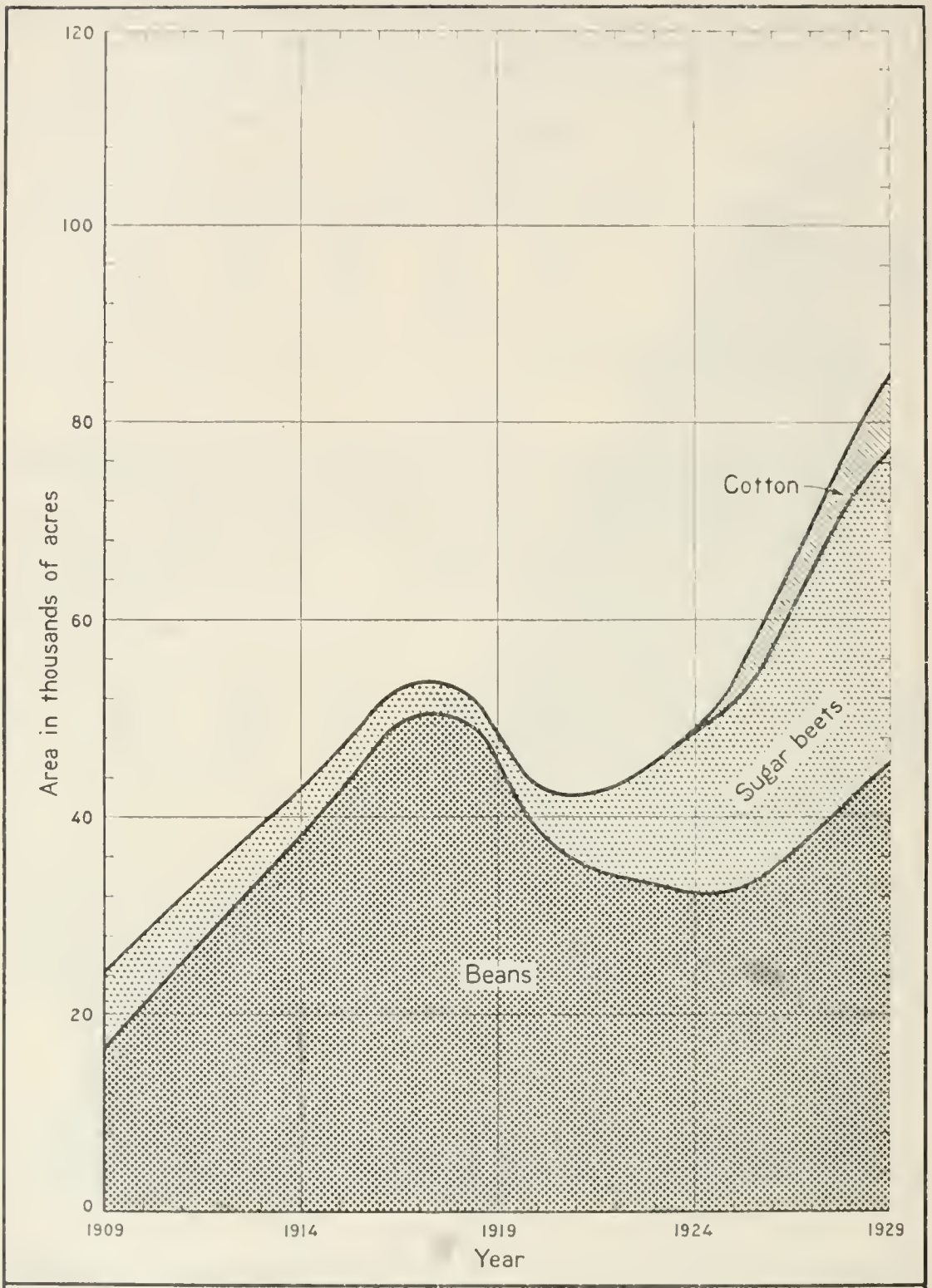
[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

grain hay acreage decreased from 70 per cent to 30 per cent, as will be seen in Table 37. Other tame and wild hay, as well as grain hay, decreased in acreage during this period, and hay acreage as a whole, even though offset to some extent by the increased alfalfa acreage, decreased about 33 per cent.

Cereals.

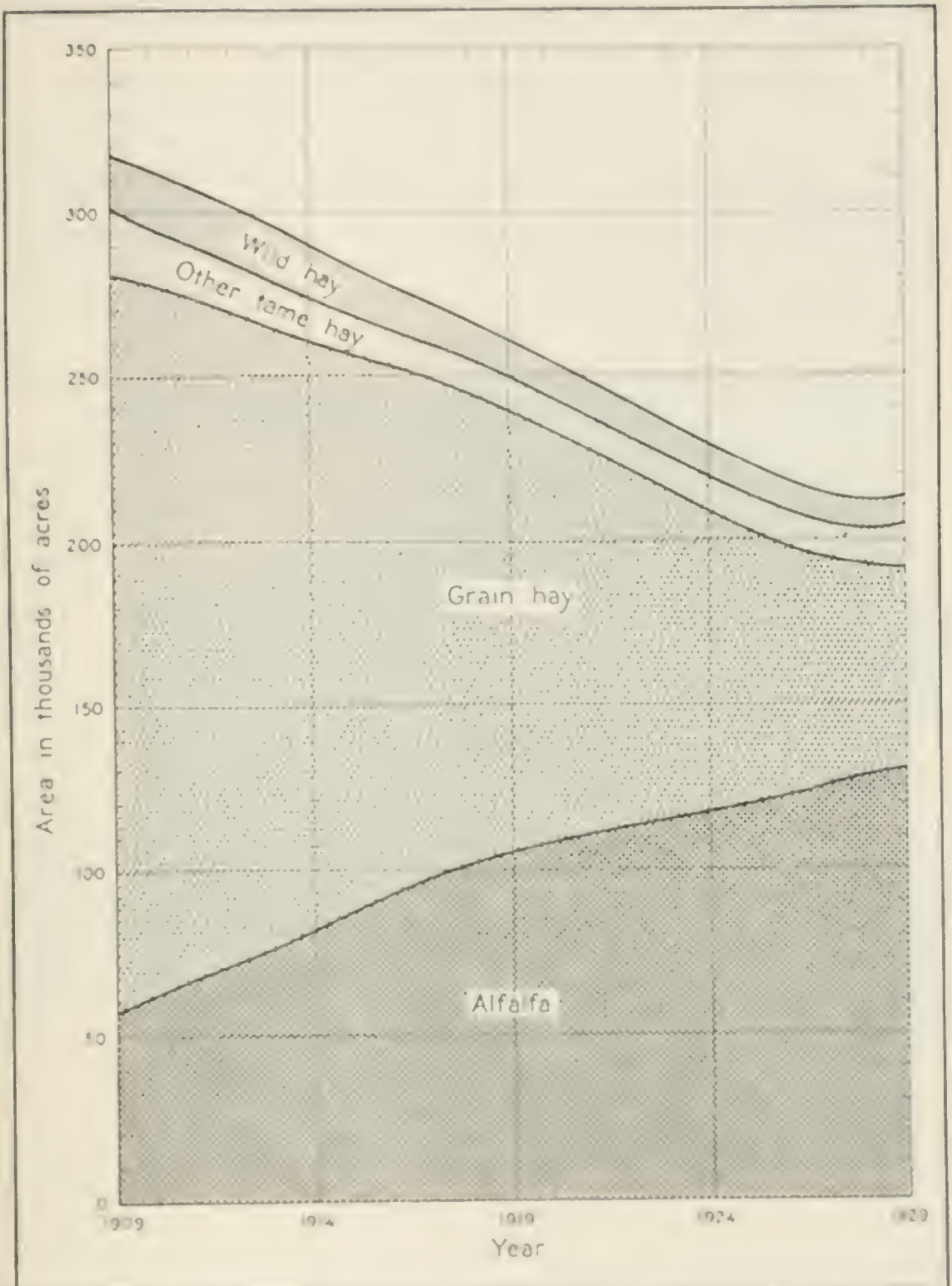
Sixty-four per cent of the cereal acreage in the state is found in these nine counties. This acreage has increased 71 per cent from 1909 to 1929, the greater part of the expansion coming during the first decade. It will be seen by observing Table 38 that almost 60 per cent of the total cropped acreage in the Sacramento Valley is devoted to the production of these crops, and within this group, barley is especially important. Plate XXXV shows how the relative importance of the different cereal crops has changed during the past two decades. Although the barley acreage decreased during the five-year period from 1925 to 1929, the acreage for the two decades increased 31 per cent. The area in wheat has increased steadily over the 20 year period. Prior to 1912, no rice was produced in the Sacramento Valley, but in that year 1400 acres were reported for this region. This acreage rapidly expanded until in 1922 there were 135,400 acres planted to this crop. The rice acreage during the subsequent years was reduced until

Plate XXXIII



TRENDS IN THE COMBINED ACREAGES
OF
SUGAR BEETS, BEANS AND COTTON HARVESTED
IN THE
SACRAMENTO VALLEY

Plate XXXIV



TRENDS IN THE ACREAGES
OF
HAY AND FORAGE CROPS HARVESTED
IN THE
SACRAMENTO VALLEY

in 1929 there were 82,000 acres. In recent years Sacramento Valley rice acreage has represented about 89 per cent of the rice acreage of the state. This percentage, however, has been variable.

The significance of the changes in land utilization as described in this chapter will be developed through the chapters which are to follow, in which also will be found explanations for many of the trends shown in the foregoing illustrations. Per capita requirements for agricultural land in the past, although of great significance, can not be used blindly in our estimates for the future. Changes in requirements for food for human beings and feed for livestock, shifts in the percentage of total United States production of fruits and vegetables represented

TABLE 38

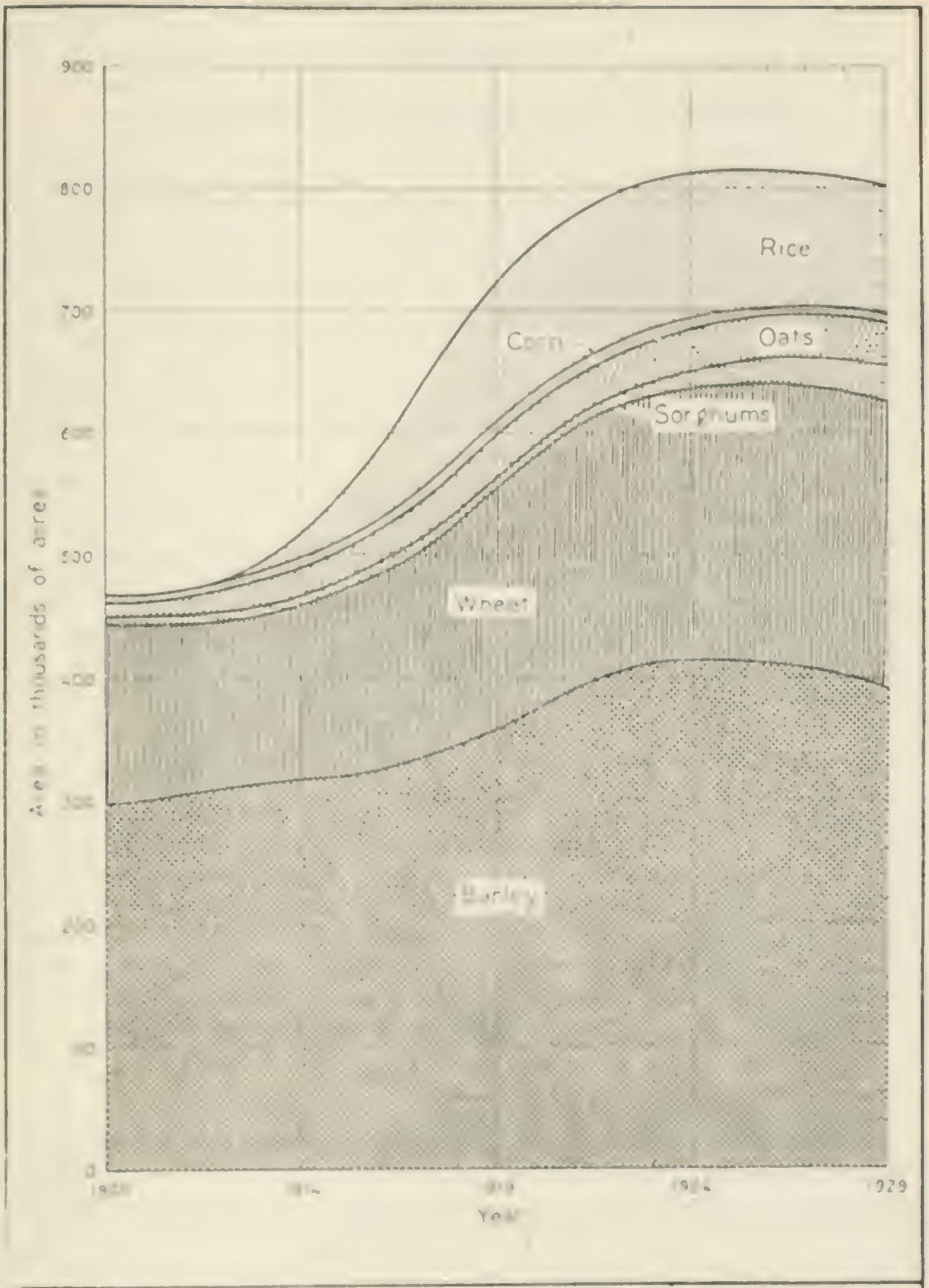
THE RELATION OF THE SACRAMENTO VALLEY ACREAGES OF THE CEREAL CROPS TO THE TOTAL FOR THAT GROUP AND THE PERCENTAGE INCREASE OR DECREASE IN THE ACREAGE OF EACH

Group and crop	Percentage of total cereal crop acreage			Percentage increase or decrease in acreage[1]		
	1909	1919	1929	1909-29	1909-19	1919-29
Cereal crops	100	100	100	71	55	10
Rice		16	13	7,507	8,042	—7
Corn	1	1	1	76	152	—30
Sorghum grain	1	1	4	746	106	311
Wheat	32	27	29	59	32	20
Barley	63	50	49	31	21	8
Oats	3	5	4	113	152	—15

[1] Minus sign indicates a decrease.
Percentages are computed on basis of trends.

by California production, and resulting changes in the use of irrigated crops, must all be subjected to analysis before an intelligent estimate can be made of the rate at which irrigated land can be made available without danger of aggravating further the economic condition of agriculture. The next chapter considers changes in human food requirements and is presented in defense of the estimates of per capita consumption used in succeeding chapters.

Plate XXXV



TRENDS IN THE ACREAGES
OF
CEREAL CROPS HARVESTED
IN THE
SACRAMENTO VALLEY

CHAPTER V

TREND OF HUMAN FOOD REQUIREMENTS

The rate at which our land and water resources may be utilized will be affected by certain important changes taking place in food consumption by the human population. From the standpoint of requirements for irrigated land in California we are particularly interested in per capita requirements for fruits and dairy products. However, it is important to realize that these are dependent upon the total intake of food per capita, and if we are to expect a marked increase in the per capita consumption of one product a more than proportionate deduction must be made with regard to others because of a declining total per capita requirement.

How much will the average adult man eat per day 50 years from now and how will it differ from what he eats today? The authorities in the field of nutrition point toward a per capita decrease. The factors enumerated by these authorities tending toward this lower food requirement are many. The type of occupation and conditions of industry are changing. The exposed occupations, such as agriculture and forestry, are drawing a decreasing proportion of the population, and as the occupations become more and more sheltered the food needs of those employed become correspondingly smaller. Not only is the percentage engaged in the outdoor occupations decreasing, but, due to increased mechanization, the actual physical strain of industry is being decreased. Also, through the agitation of those interested in the welfare of labor, the average number of hours the men are working is being reduced and with this reduction goes a reduction in energy needs. All indications seem to show the occupations of the human race are becoming more and more sedentary. Furthermore, better heated houses, mechanization of pleasure as well as work, in the wider use of the automobile, and the tendency of fashion to dictate the thin figure all have tended to change the composition of the human diet.

Methods of Estimating Food Requirements.

There are two general methods used by investigators in estimating food requirements of human beings. One is based upon statistics of production, making allowances for imports and exports, reducing these figures to a per capita basis and finally converting this result to energy value, usually expressed in calories. The other is to use the results of actual experimental studies conducted under laboratory observation or the selection of groups where statistical analyses are made of actual food consumed.

If both of these methods always led to accurate determinations either would serve splendidly as a guide in determining trends, not only in total food consumption but also in specific classes of food which would lead finally to a basis of determining land requirements for the specific agricultural products. We are confronted with many difficulties, however, in applying the estimates which have been made along this line.

In the first place, having determined on a satisfactory basis the total requirements measured in calories, there is still abundant room for shifts in consumption among the various products composing the diet. Observations in one locality, while a good measure of total requirements, will not apply to another locality as to specific proportions of the different foodstuffs. Not only is this true, but the different bases of estimate lead to different results because of varying degrees of accuracy of the basic data. Our statistics of production, particularly with regard to live stock and live stock products, are subject to some question as to accuracy. Figures on slaughter of manufacturing concerns are probably very reliable. Data on slaughter on farms are also obtainable, but there is a large element of error in other local slaughter figures where the packing houses are not under public inspection.

Finally, in the application of such studies to one particular portion of a great nation, such as the United States, all of these difficulties are magnified. In addition, the free movement of agricultural products from one portion of the country to another, in response to more favorable advantage for production in one part of the country than in another, gives rise to a difficult problem of converting food requirements into land utilization in that particular area.

But a discussion of tendencies in food requirements is important from a standpoint of observation of changes taking place in the United States, and which may affect our local problem, in order to forestall criticism of the basis of forecast later recommended.

Pre-war Per Capita Food Requirements.

In order to estimate food requirements for a nation or state it is necessary to adjust estimates of requirements for adults to make them applicable to a population of mixed ages of both sexes. This is usually accomplished by converting the number of persons of all ages to the number of male adults requiring the same amount of energy in food. Raymond Pearl, who has estimated, on the basis of pre-war consumption statistics, the average energy requirements for an adult man at about 4300 calories per day, makes the following statement as to procedure:

> In reducing consumption data to a per capita basis it would obviously be foolish to take the actual total population as a base, for the reason that the amount of food consumed changes with the age of the individual, particularly in early life. On account of this fact the usual practice in computations of this kind is reduced, not to a per capita basis, but to an adult man basis. In doing this a fractional factor is used to multiply the number of individuals of certain lower ages, the magnitude of the factor being proportional to the relation which the nutritional intake of the individual at the younger age bears to that of the average adult man.*

Accordingly Pearl reduces the population to an adult male basis by multiplying the numbers of children 5 years of age and under by 0.5, and the numbers of those between 6 and 13, inclusive, by 0.77. The number of boys from 14 to 18, inclusive, and the entire female population above 13 he multiplies by 0.83, while the male population above 18 is considered as 100 per cent.

* Pearl, Raymond. The Nation's Food, pp. 214-218. W. B. Saunders Company, Philadelphia, 1920.

It is interesting to note, however, that Holbrook Working * places the food needs of boys from 14 to 18 years, with free opportunity for play, at 5000 calories, while those of the average man engaged in light work (a teacher or salesman) and incidental activity is placed at 2400 to 2700 calories per day. This would make the conversion factor about 2.00 for males from 14 to 18, rather than 1.00 as Pearl has it. Although a boy may occasionally eat twice as much as his father, it is doubtful if many of them maintain this ratio for the same type of food is served to both at the family table. Growing children as a rule, however, obtain a large percentage of their total food requirements in the form of candy.

Probable Future Food Requirements.

Taylor † predicts for a period of 50 years from the date of his writing, a considerable decrease in the per capita requirements per adult man per day as compared with the requirements estimated by Pearl. Taylor sets the requirements at about 3500 calories, which figures include waste. When corrected for this factor, food actually ingested amounts to 2800 or 2900 calories.

In order to analyze the probable changes in the consumption of the various foodstuffs in the future it is necessary to separate the total energy requirements into its components on the basis of general classes of foodstuffs. The segregation set forth by Taylor has been used and Pearl's figures have been reclassified and combined to make them comparable to Taylor's.

Table 39 combines in six important groups the gross consumption of human foods per adult man per day as estimated by Pearl for the years 1911 to 1912, to 1915 to 1916, inclusive, and also gives the average for this five-year period. In Table 40 the percentage distribution in the total for these same major food groups is given, and in the same table may be found Taylor's estimates for the same classes of foods for a future period, about one-half century hence.

TABLE 39

GROSS CONSUMPTION IN CALORIES PER ADULT MAN PER DAY IN THE UNITED STATES

Year	Milk and products	Cereals	Meat (including fish, poultry and eggs)	Vegetable oils, nuts, fruits and vegetables	Sugar	Oleomargarine	Total
1911-12	666	1,488	1,059	505	552	15	4,285
1912-13	649	1,456	1,023	553	570	17	4,268
1913-14	648	1,620	981	524	604	17	4,394
1914-15	648	1,388	1,061	582	580	16	4,275
1915-16	656	1,559	1,042	506	535	17	4,315
Five-year average	653	1,502	1,033	534	569	16	4,307

Sources of data and basis of estimate:

Pearl, Raymond., The Nation's Food, pages 252-256, Table 77, W. B. Saunder's Company, 1920.

Data for 1917 and 1918 were omitted because of the abnormal influence of the war on per capita consumption. In the original table by Pearl the items were given in much more detail. These were segregated into the above groups and averages computed for this report.

* Working, Holbrook, The Decline in Per Capita Consumption of Flour in the United States. Wheat Studies of the Food Research Institute, Vol. II, No. 8, page 281. Stanford University, July, 1926.

† Taylor, Alonzo E., The Future Food Supply of the United States. Delivered before the New York Academy of Medicine, October 20, 1927. Reprint from the Bulletin of the New York Academy of Medicine, November, 1927. 23 pages.

TABLE 40

PRE-WAR GROSS CONSUMPTION IN CALORIES PER ADULT MAN PER DAY COMPARED WITH ESTIMATED FUTURE REQUIREMENTS

Foodstuffs	Averages of Pearl's gross consumption, 1911-1915		Taylor's estimated segregation, 50 years hence		5
	1	2	3	4	Ratio, column 3 to column 1
	Calories	Per cent of total calories of column 1	Calories	Per cent of total calories of column 3	
Milk products	625	13 1	550	16	0 84
Cereals	1,502	34 9	1,300	37	0 86
Meats (including fish, poultry and eggs)	1,065	24 0	600	17	0 58
Vegetable oils, fats, fruits and vegetables	574	12 4	600	17	1 12
Sugar	501	11 2	450	13	0 79
Oleomargarine	16	4			
Totals	4,307	100 0	3,500	100	0 81

Sources of data and basis of estimates

Column 1 is composed of the five-year averages given in Table 39.

Column 2 contains the percentage which each item in column 1 bears to the total of the items in column 1.

Column 3, Taylor, Alonzo E. The Future Food Supply of the United States. Delivered before the New York Academy of Medicine, Oct. 20, 1927. Reprinted from the Bulletin of the New York Academy of Medicine, Nov., 1927, page 9.

Column 4 contains the percentage which each item in column 3 bears to the total of the items in column 3.

Interpretation of the Estimates of Pearl and Taylor.

Because of considerations mentioned above the apparent percentage decline in the probable consumption of the different products must not be given undue weight. The estimates of Pearl were based upon production and foreign-trade figures and included an estimate for waste over and above the actual ingestion. When corrected for the factor of waste the estimated requirements of 4300 calories per day for the adult male was reduced to 3424 calories. However, Pearl recognized the fact that this corrected estimate was still high, for in the case of fats the total edible wastage had not been subtracted. The estimates of Taylor were based upon scientific knowledge of total human energy requirements, realizing that there might be some variation in the segregation into different classes of food. In the case of Pearl's estimate the statistics, upon the basis of which the consumption estimates were made, determine the distribution of the total calories required among the various products. The total energy requirement given here is very generous in comparison to many others. Ballod * in discussing the gross nutrition requirements in Germany in 1914 in the early months of the war gives for England a per capita requirement of 2900 calories; Italy 2607; France 2749; Austria 2486, and the United States 2925. In these same countries the per capita requirements for milk and milk products were estimated as follows: England, 439 calories, Italy, 120; France, 312; Austria, 251, and the United States, 431. These estimates do not include butter substitutes or vegetable oils.

A group of noted German economists, including Friedrich Aereboe, Carl Ballod and others, in a study of pre-war food requirements for

* Ballod, Von Josef. Die Volksernährung in Krieg und Frieden, pages 77 to 112. Berlin Grunewald.

Germany estimated a total per capita requirement of 3642 calories, which included an estimate of 478 calories in dairy products.*

A similar commission† reporting on the resources of the Allied countries in the early years of the war estimated the energy requirements for the adult male of France at 3300, of Italy 3000, of the United Kingdom 3300, of the United States 3300. Food consumption experience in the United States formed the basis for most of the estimates by this commission. In the same report a table, compiled from government reports issued in the early part of 1918 giving the distribution in millions of calories derived from the different food products, is given. Of the total food requirements in staple products of the United States, 11.3 per cent were dairy products.

The value of reviewing these various estimates lies principally in noting their variability and showing the necessity of avoiding error in the establishment of future trends of food consumption based upon the estimates of different groups of individuals made by means of different methods and sources of data. What the figures presented do show, however, is that *there is an upper limit to the total per capita requirement and, therefore, an upper limit to recent trends in per capita consumption of some of the important foodstuffs.* With this in mind it might be well to review some of the recent studies in the trend of per capita consumption.

Trends in Production and Consumption.

Working ‡ has charted the apparent United States per capita consumption of the four principal dairy products, namely, cheese, ice cream, condensed milk and butter, in terms of whole milk. There has been a very noticeable increase in consumption per capita since 1917. With regard to California, however, it appears that the rapid increase of per capita consumption of dairy products, although undoubtedly to some extent due to permanent changes taking place in the human diet, has been in part due to a period of deficiency in dairy products following unprecedented immigration to this state during the decade 1900 to 1910.

It is significant also that during this same period of deficiency in California there was an apparent sag in the United States per capita consumption. Baker § gives figures compiled by the Dairy and Poultry Division of the United States Bureau of Agricultural Economics which "indicate a per capita consumption of all dairy products reduced to a milk basis of about 880 pounds at the beginning of the Twentieth Century (1897–1901), which decline to less than 860 pounds in the period 1902–1906 and further decline to about 830 pounds in the period 1907–1911, with a very slight further decline in the period 1912–1916.

* Aereboe, Friedrich, et. al. Die Deutsche Volksernährung und der Englische Aushungerungsplan, page 63. Edited by Paul Eltzbacher. Published by Druck und Verlag von Friedr. Vieweg & Sohn in Braunschweig. 1915.

† Commission Scientifique Internallie du Ravitaillement. Les Ressources et les Besoins Alimentaires des Pays Allies. Premier Rapport. Approuve par la Commission, Paris. Octobre, 1918. Imp. Lang, Blanchong et Cie, 7, rue Rochechouart, Paris.

‡ Working, Holbrook. The Decline in Per Capita Consumption of Flour in the United States. Wheat Studies of the Food Research Institute. Vol. II, No. 8, page 276. Stanford University. July, 1926.

§ Baker, O. E., Do We Need More Farm Land? Pages 19-20. Address Agricultural Extension Conference, University of Minnesota, St. Paul, Minnesota. Dec. 13 and 14, 1928. Mimeographed by U. S. Dept. Agr., Div. of Agr. Econ.

Then came the change, indeed the upward trend started in 1915, and was under full swing by 1918. The per capita consumption rose to an average of about 880 pounds for the period 1917–1921, and then, gaining momentum, mounted to about 990 pounds for the period 1922–1926. Consumption at the present time (Dec., 1928) is fully 1000 pounds per person, according to the estimates of the Bureau of Agricultural Economics. The consumption of milk per capita is now (Dec., 1928), apparently, 12 per cent greater than 25 years ago, and nearly 20 per cent greater than in the period 1912–1916."

Uncertain as the statistics on milk products are in the early period of the last three decades, there is an indication that the population grew more rapidly than the dairy industry during the first decade of the century and that only in recent years has the supply tended to overtake the growth in numbers of people. In observing per capita trend in butterfat consumption, therefore, we must not misinterpret cyclical changes in per capita consumption or production in terms of trend. In other words, we cannot hope for the rapid increase in butterfat consumption which has taken place during the past decade to continue indefinitely. In fact, present per capita consumption may not be maintained. The present apparent consumption of butterfat in all dairy products in California is approximately 33 pounds per capita. *In the light of apparent necessary cuts in total human food requirement, more complete utilization of the total energy contained in whole milk, reduction of waste and trends in the consumption of other elements in the human diet, it seems that the present consumption per capita is the safest figure to use in approximating requirements for the future in California.*

Trends in the age composition of the population can not be ignored in looking forward to per capita requirements for milk in the future. It has been suggested in a previous chapter that, although we may have a proportionately larger number of children during the latter part of the current decade and throughout the one following, the general trend in the ratio of children to total population is downward. There seems, however, to be an increasing tendency for older persons to drink milk.

California will continue for some period of time in the production of her own supply of market milk, cream and ice cream. There is already a tendency to increase imports of butter and cheese. It is necessary, therefore, to give consideration to these two different groups of dairy products in an estimate of land requirements. The problem of separating this factor into its two phases, i. e., that portion representing shipments into the state from outside and those products which will continue to be produced in California, has been reserved for discussion in the next chapter.

Future Requirements for Fruits and Vegetables.

Although fruits and vegetables have a low calorie value in proportion to the space they occupy, they now represent an important percentage of the total diet and most authorities agree that they will occupy a place of increasing importance as time goes on. In the analysis made of the estimates of Pearl and of Taylor in Table 40 above, vegetable oils, nuts, fruits and vegetables represent 12 per cent of the total requirements in Pearl's estimates and 17 per cent in Taylor's estimates for the future.

Statistics on United States and California production of fruits, however, together with trends in the consumption of sugar, which will be indicated in a later paragraph, indicate the necessity for caution against too much optimism with respect to a rapid increase in the per capita consumption of fruits. Just as in the case of dairy products, there has been a very marked increase in the use of fruits in recent years, but there also is indication that in the earlier years of the two decades just passed, apparent per capita production of fruits in the United States was much greater than during the period of the war and the years just preceding and subsequent to the war. The earlier period of relatively high fruit production in the United States was characterized by a relatively large production of temperate zone fruits, whereas in the later cycle the production of sub-tropical fruits has been an important factor. The period of low production probably brought about the prices which led later to the too rapid expansion of fruit acreage.

On the whole, however, throughout the entire period of the declining preference for the apple and the coming in of the orange and grape the decreases in the production of temperate zone fruits and increases in sub-tropical fruit production have more or less balanced each other and a conclusion may be reached that, while there has undoubtedly been an important increase in the actual ingestion of fruits, the per capita production, as indicated by the trend over the past 20 years, has increased but little. The earlier years were probably characterized by a greater amount of waste, and perhaps a greater proportion of consumption was obtained from home orchards. The present period is characterized by a larger percentage of urban population, a smaller proportion of the total production in family orchards and a larger percentage of the total consumption entering channels of trade where statistics on production are available for the basis of estimates.

Production statistics in the United States show the combined effects of many influences in the past, including United States consumption and net shipments to foreign countries. It is a question, therefore, so far as the present objective is concerned, if it is expedient to try to estimate either United States or California per capita consumption of fruits when *trends in per capita production* would seem to serve our ends so much more completely.

Sugar.

The trend in sugar consumption is important, not so much because of California's sugar beet acreage, nor because of her industries in the refinement of cane sugar, but primarily because of the high energy value of sugar and its tendency to replace other commodities. A comparison of estimates of Pearl and Taylor in regard to the place of sugar in the diet indicate that although sugar has about the same relative importance in proportion to other commodities in each of the two estimates, the total sugar requirements has been materially reduced in the estimate by Taylor because of the reduction in total requirements. Although total requirements for energy in food is declining, sugar has experienced a long upward trend in per capita consumption. The per capita consumption of 52 pounds in the United States for 1889, as

shown by Working's * chart, rose to 112 pounds per capita in 1924. Recent statistics show that this upward trend still continues. Just when the break in the per capita consumption of sugar will come and when the downward trend will begin is difficult to say. Increased use of fruits means increased use of sugar. Increased use of sugar means increased total calories per man, unless some other commodity gives way.

Meats.

There was a high point in United States per capita meat consumption in 1907 and others in 1923 and 1924. The per capita consumption in the latter period reached 149.7 pounds per year, while in the earlier period this was exceeded by 4.6 pounds. The lowest per capita consumption recorded since 1900 was 120.1 pounds in 1917. There is only one such minimum in the recent data made available by the United States Department of Agriculture.† If the difference in the five-year averages centered at the maxima of these periods of high consumption be taken as an indication of the trend, consumption dropped 3.7 pounds in seventeen years, or at the rate of 2.18 pounds per decade. This is 1.57 per cent of 138.4, the average United States per capita consumption in pounds for the eleven years from 1907, a year of maximum consumption, to 1917, a year of minimum consumption. At this rate we may expect a little more than 6 per cent decrease by 1970. Although meat constitutes nearly a fourth of the nourishment of the human body, a cut of 6 per cent is not going to leave a sufficient amount of room in the contracted human stomach of 1970 to justify any appreciable increases in per capita consumption of other foods.

Cereals.

Cereals also have declined in importance in the human diet. While the estimates of Pearl and Taylor indicate approximately the same proportions of the diet to consist of cereals, the difference in the total food requirements, as in other groups, indicates a smaller total requirement for cereals in the estimates of Taylor.‡ Working § shows a steady decline in the trend of wheat consumption in the United States from 1901 to 1925. Later studies by him, as yet unpublished, indicate an abrupt drop in per capita consumption immediately after the close of the war. Taylor states that the world at large is consuming more wheat, but that there has been a per capita decrease in those countries where other cereals have been relegated to a minor position and where the standard of living is such as to permit a diversification of the diet. Such diversification leaves wheat a smaller place and such a country is the United States. It seems quite probable that this downward trend will continue as time goes on and that per capita consumption will grow continually less.

* Working, Holbrook. The Decline in Per Capita Consumption of Flour in the United States. Wheat Studies of the Food Research Institute. Vol. II, No. 3, page 278. Stanford University, July, 1926.

† U. S. Dept. of Agr., Bur. Agr. Econ., Statistics of Meat Production, Consumption and Foreign Trade of the United States 1908–1923. Preliminary Report (Mimeographed). April 1926.

‡ Taylor, Alonzo E. The Place of Wheat in the Diet. Wheat Studies of the Food Research Institute. Vol. V, No. 4, page 148. Stanford University, Feb. 1929.

§ Working, Holbrook. The Decline in Per Capita Consumption of Flour in the United States. Wheat Studies of the Food Research Institute. Vol. II, No. 8, page 273-282. Stanford University, July, 1926.

Further declines in wheat and meat consumption seem to be the only present means of making room for increases in the use of dairy and fruit products. Decline in the consumption of meats probably will not be rapid because of their palatability. Decreased wheat consumption may continue to make possible increases in the consumption of sugar, fruits, milk and vegetables, but when account is taken of the fact that we have apparently just passed the maxima of cycles in consumption of both milk and fruits, that we must allow for some decrease in total food requirements and that trends of the past in the production of both fruits and dairy products indicate recent increases are not entirely due to permanent changes, but are in part cyclical, it seems we are on the side of optimism when we use present per capita consumption of dairy products and a 20-year average per capita production of fruits in the consideration of future requirements.

CHAPTER VI

PAST, PRESENT, AND FUTURE LAND REQUIREMENTS FOR THE SUPPORT OF CALIFORNIA LIVE STOCK INDUSTRIES

Important changes have taken place in the live stock industries of California which have a significant bearing upon the economic aspect of irrigation development. During the past 20 years the number of sheep and dairy cattle have been increasing, while the number of beef cattle, swine, horses, mules and goats have been on the decline. Plate XXXVI shows the trends during this period in the number of various kinds of live stock.* Much of the feed required for our live stock industries is produced on irrigated land. While the beef and sheep industries are largely concerned with the utilization of grazing lands, even these phases of our agriculture are closely related to the more intensive agricultural development in our irrigated areas through the increase of supplementary feeding of concentrates and hay, and because of their competition with irrigated crops in furnishing the total requirements for food for the population of California and of the entire country.

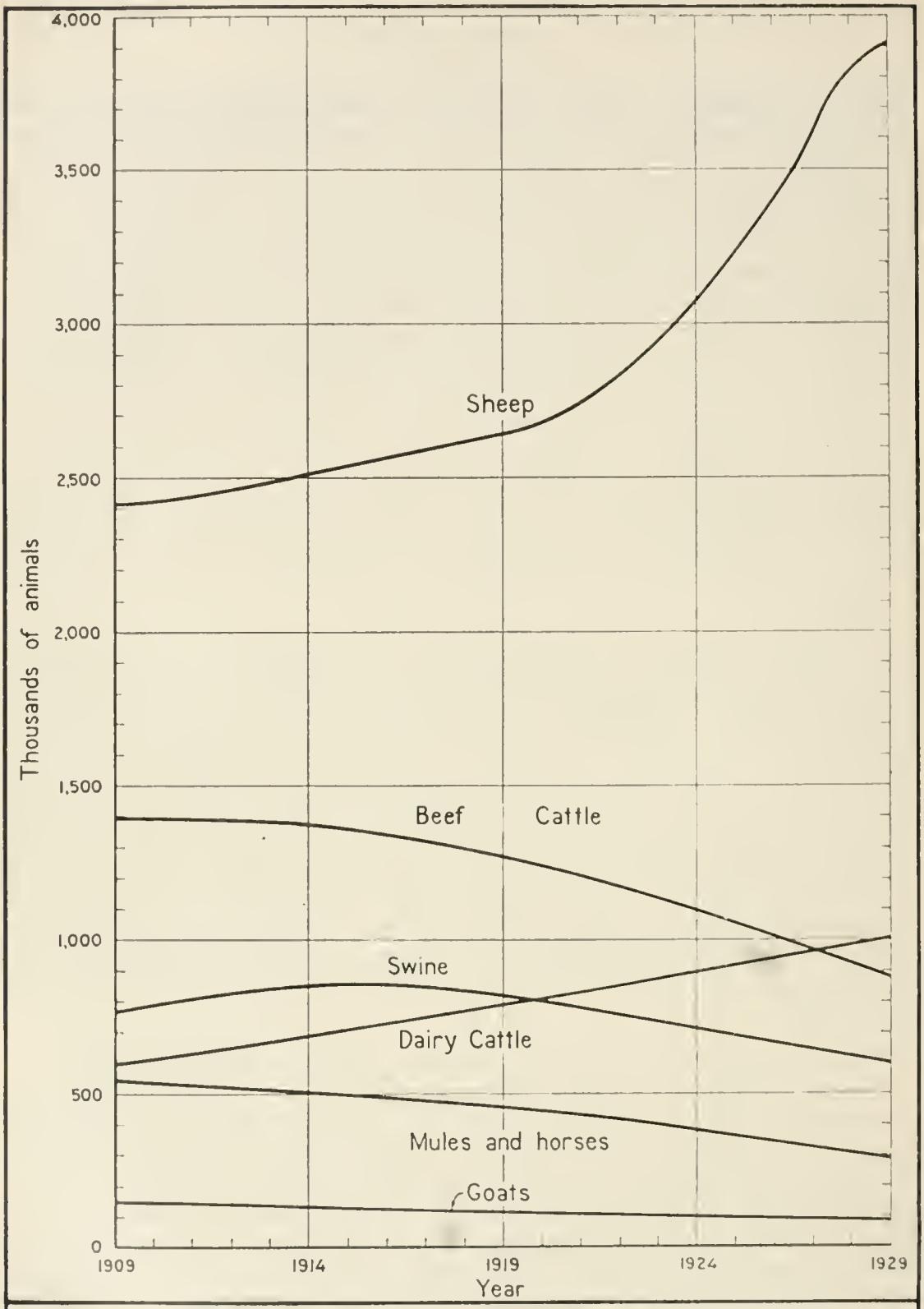
Furthermore, an estimate of feed requirements for the dairy industry can only be made by a consideration of requirements for other live stock. Many gaps in the available statistics must be bridged by indirect methods, which require the check made possible by summarizing the requirements for all live stock, and by balancing available feed against feed use. An important part of our meat supply is derived from our dairy herds. Hay formerly fed to horses is now fed to dairy stock, cattle and sheep. Grain formerly used for other purposes is now fed to dairy cattle, poultry, hogs and beef cattle, and to a certain extent is replacing alfalfa. Our pasture resources contribute to the production of butterfat, beef, veal, lamb and wool. Because of these facts and for other reasons, it is necessary to estimate land requirements for the entire live stock industry before an estimate can be made for any one of its parts.

Methods of Analysis of Land Requirements for the Live Stock Industry.

The general plan of this investigation has been in brief to determine the past and present feed requirements for the production of live stock products, to express these in terms of total digestible nutrients required for the total California production, to estimate changes in these requirements and to forecast future needs on the basis of California and United States population and estimated per capita consumption, and finally to convert these feed requirements into acres of pasture and irrigated and unirrigated crop land on the basis of probable proportions in the ratio of pasture, roughage and concentrates, and yields of feeds supplying these, taking into consideration probable importations of products and of feeds. The proportion of the land requirements for the entire state that will be supplied by the development of irrigation

* Inasmuch as the feed requirements per animal in Arizona-Mexico are much greater with respect to beef as compared to sheep, the rapid increase in the number of sheep should not be given undue emphasis.

Plate XXXVI



TRENDS IN THE NUMBERS
OF
CALIFORNIA LIVESTOCK

in the Sacramento and San Joaquin valleys will be determined largely by the quantity and adaptation of different classes of land situated within those valleys in comparison with the lands in other sections of the state.

Pounds of Digestible Nutrients as a Measure of Feed.

In order to simplify the determination of land requirements for the support of the live stock industry, the many types of feed used, the many classes of land upon which they are produced and the results of different feeding practices must be reduced to some method of expression which will make possible a reduction in the number of variable factors in the problem. Cattle are fed different proportions of concentrates and roughage, and varying amounts of pasture per cow are available in different localities. Prices of feed vary, making it necessary to adopt an entirely different feeding program in different parts of the state, and, what is most perplexing, there is a wide variation in the amount of these different feeds required to produce a given amount of any of the live stock products. For the purpose of measuring feed requirements some common unit of feed which will make possible comparisons and summaries of feed and land requirements must be adopted. For this purpose probably the simplest device is to reduce the different types of feed to their equivalent in digestible nutrients.

Very elaborate studies have been made by many investigators of the nutritive value of different feeds. The concentrates vary somewhat in nutritive value, but average between 0.75 and 0.80 of their weight in digestible nutrients. About half of the weight of alfalfa hay gives us the weight of digestible nutrients. Likewise roots, green feed, silage and other feeds may all be expressed in pounds of digestible nutrients and the total consumption expressed as a sum. This sum, determined from large numbers of cases in different parts of the state, not only for dairy, but also for other types of live stock, gives us a basis for estimating present consumption of feed per unit of product produced and a unit which may be projected into the future regardless of changes that may come in the rations fed.

Changes in Agricultural Efficiency and Their Relations to Land Requirements for the Live Stock Industry.

The number of dairy cattle increased 64 per cent from 1910 to 1930. Production of butterfat in this same period increased about 100 per cent. In other words, the production of butterfat per cow greatly increased. There also has been an increase in the output of poultry products per pound of feed. In 1920 the average production of eggs per hen in California was approximately 102 eggs. In 1924 the production per hen had increased to 127 eggs. Similar changes have taken place in the production of beef, lamb and pork products.

What effect have these apparent changes in efficiency had upon the land requirements? A knowledge of feed requirements per unit of product is essential for the answer to this question. Data are more available for the determinations within some of these industries than within others. Fortunately our knowledge concerning those industries

which are more important to irrigation development is more extensive than for many of the other groups. Statistics, however, are inaccurate for the earlier years, making the study of changes somewhat difficult. A careful weighing of data from different sources, however, makes it possible to develop the means of measuring the effects of changing efficiency upon requirements for land.

Future trends of land requirements for the live stock industry will depend upon a great many variable influences. Live stock products derived from our grazing resources will be produced in greater quantities only as the range is improved, as husbandry is practiced more efficiently, or as California more and more specializes in the feeding and fattening business. The poultry industry will be influenced by national and state growth and by California's apparent advantage in egg production. Butterfat production has the complications of varied types of products, some of which will be subject to competition from other states and some of which will continue to be produced here. Swine will take such feed as is left after the wants of other animals and human beings have been satisfied. Horses will continue to release feed for all of these. What will be the net result?

THE DAIRY INDUSTRY

The most important of the live stock industries from the standpoint of irrigation is the dairy industry. The other live stock enterprises, however, consume almost a fourth of the hay produced in the state and use other supplementary feeds. In order to determine future land requirements for the dairy industry in California it is necessary to have a knowledge of the production and consumption of dairy products, imported supplies, tendencies with regard to efficiency in milk production, changes in feed rations, relative costs of imported feed supplies, as compared to products of California lands, and trends in human requirements for dairy products and in population growth.

Production and Consumption of California Dairy Products.

A comprehensive discussion of the production and consumption of California dairy products has been prepared by Professor E. C. Voorhies* of the University of California. The present discussion, therefore, will be limited to presentation of the results of an analysis of the trend of the California butterfat production, classified on the basis of its utilization in importable and non-importable products, and a determination of per capita requirements of these products, with a view to conversion into feed and land requirements. It is recognized that milk products are used for a wide range of purposes and that there has been a rapid development in recent years in the utilization of the solid portions of the milk, other than the butterfat it contains. The demand for butterfat, however, will control the general demand for milk products. Butterfat production, therefore, is a very useful index of the growth of the entire industry. It is very important to consider the growth in the demand for butter, cheese and condensed and evaporated milk separately from market milk, cream and ice cream, inasmuch

* Voorhies, E. C., Economic Aspect of the Dairy Industry. California Agr. Exp. Sta. Bul. 437: 42–72. 1927.

as the former are importable and their importation is on the increase, while the latter are largely products which must be consumed relatively near the area of production.

Table 41 and Figure 1 of Plate XXXVII have been prepared to indicate the trends in California butterfat production for the past 30 years. The data in the earlier years, upon the basis of which these trends have been established, are undoubtedly less accurate than those of more recent years. The 1909 estimate, taken from the census, has been altered by the census bureau. This revision has consisted of adding to the original reported production of milk, estimates of production omitted in the original enumeration. What has been the basis of these estimates is not known. Whatever may have been the accuracy of these earlier data, the trend line passing among them is probably representative of the approximate growth of dairy production.

Throughout the decade 1909 to 1919 and later there was a period low in per capita production and consumption in California. Prior to 1909 there was a period during which the per capita production was probably higher than it was from 1909 to later than 1919. Since 1919 there has been a rapid increase in the per capita production of dairy products, as has been the case in the entire United States. The extraor-

TABLE 41

TREND OF CALIFORNIA BUTTERFAT PRODUCTION, CLASSIFIED ON THE BASIS OF UTILIZATION IN IMPORTABLE AND NON-IMPORTABLE PRODUCTS

Year	Thousands of pounds of butterfat in					
	1	2	3	4	5	6
	Butter	Cheese	Condensed and evaporated milk	Butter, cheese and condensed and evaporated milk	All dairy products	Market milk, cream, ice cream and miscellaneous products
1899	27,370	801	309	28,579	51,840	22,967
1909	41,371	859	1,209	43,197	78,881	37,784
1919	54,997	3,247	3,037	60,481	92,713	32,232
[illegible]	62,142	2,436	9,982	74,481	(1924) 114,149	
1929	60,111	7,932	11,840	79,725	148,880	71,479

Sources of data:

Column 1. The total production of butter 1899, 1909, 1919 and 1929 was obtained from: Voorhies, E. C., Economic Aspects of the Dairy Industry. California Agr. Exp. Sta. Bul. 437. 1927. [illegible]

Column 2. [illegible]

Column 3. [illegible]

Column 4. Column 4 equals column 1 plus column 2 plus column 3.

Column 5. [illegible]

Column 6. Column 6 equals column 5 minus column 4.

dinary increase in California population from 1910 to 1920 was probably more rapid than the expansion of the dairy industry, which has only recently caught up. While the number of dairy cows increased 31 per cent from 1910 to 1920, population increased 44 per cent during the same decade. This was before any outstanding progress had been made in increasing the output per cow. In addition to the total production of butterfat in all California dairy products and its utilization in the importable and non-importable products, Figure 1 of Plate XXXVII shows the consumption in recent years of the major portion of the butterfat contained in various groups of the dairy products. Adding 10 per cent to the indicated total consumption for omissions * it is estimated that the present per capita consumption of butterfat in all products in California is approximately 33.4 pounds, that the present per capita consumption of butterfat in the importable dairy products, butter and cheese, is approximately 17.0 pounds, and the present per capita consumption of butterfat in non-importable dairy products in California is approximately 13.4 pounds. Butterfat in other importable dairy products for which no statistics are available has been arbitrarily assumed at three pounds per capita.

The Trend in Feed Requirements for the Production of California Dairy Products.

Figure 2 of Plate XXXVII shows the trend in the number of dairy cows two years old and over for the past 30 years. There have been variations from this trend from year to year, due to changes in prices of dairy products, the drouth in 1924 and the hoof-and-mouth disease. Inasmuch as our objective is to estimate the long-time trend in the development of the industry for a fairly long period in the future, minor variations are unimportant. In fact, they may be very misleading. On the basis of the trend in the numbers of dairy cows and the estimates of production previously described, changes in the average annual production of butterfat per cow have been estimated. This trend is shown in Figure 1 of Plate XXXVIII. In this same illustration are shown the variations in the butterfat production per cow for the herds of Denmark, to illustrate the possibility of future improvement in California. We can not conclude, however, that it will be economical to increase California dairy production to the extent that it has been profitable in Denmark. It will be shown that the amount of feed per unit of product may not be materially changed by further improvement in the production per cow. There have, however, been important changes during the past 20 years in feed and land requirements per pound of butterfat produced in California.

Investigations of the cost of producing butterfat have been made in California during recent years. The first of these was conducted by Professor R. L. Adams, of the California Agricultural Experiment Station, and was made in 1922 and 1923.† The second of these has been conducted by the California Agricultural Extension Service, under the direction of F. L. Fluharty. These studies furnish valuable data

* Condensed and evaporated milk has not been included. There are probably other omissions.

† The Cost of Producing Market Milk and Butterfat on 246 California Dairies. Bul. 372, November, 1923.

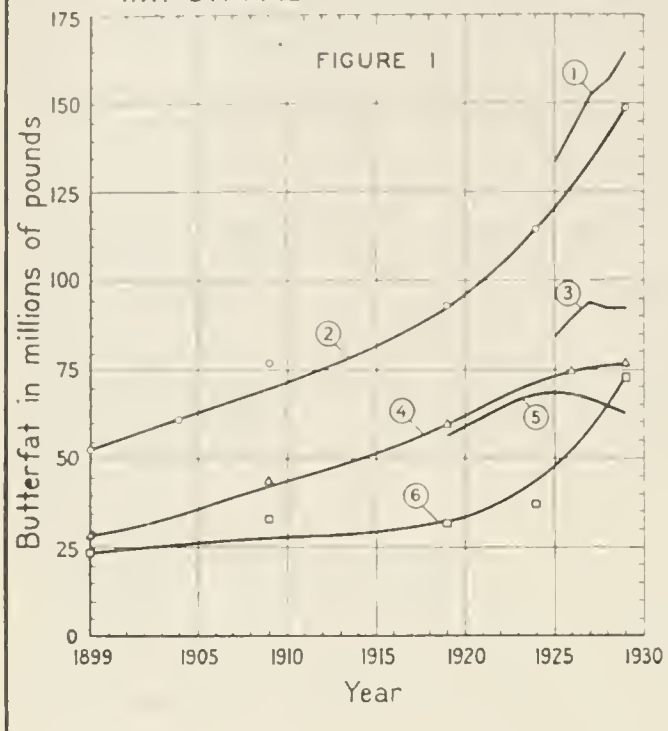
for the analysis of changes in feed requirements in the dairy industry. Feed requirements in the case of both of these studies were reduced to average number of pounds of digestible nutrients in feed per 100 pounds of butterfat produced. Separate averages were computed for cows producing different quantities of butterfat per year. Even within these groups of similar production per cow there was wide variation in the amount of feed required to produce 100 pounds of butterfat. The averages of these feed requirements, however, bring out the important fact, which must be taken into consideration in the estimate of land requirements, that the lower producing cows require a much larger amount of feed for the production of the same amount of butterfat than the higher producing cows. This is because it takes about as much feed to maintain a low producing cow as to maintain a high producing cow. The additional feed consumed by the cow giving the higher yields is for the extra milk which she produces. This has been a well-established fact for a number of years. Feed experiments have shown also that this increase in feed requirements for greater quantities of milk production is proportional to the increase in production. In practice, however, it seems that there is a limit to the reduction in feed requirements per 100 pounds of butterfat and that after an average production of 300 pounds per cow has been reached, under the conditions surrounding these studies, there is no gain in output per pound of feed, at least up to a production of 400 pounds per cow. This flattening out of the curve may be due to changes in herd composition as the production is increased. Although there is much opportunity of refinement of these estimates, they are presented here as approximations which seem adequate for the immediate purpose at hand.

That the increase in efficiency in the use of feed during recent years has been almost solely attributable to the increase in production per cow is indicated in the 1928 study conducted by the California Extension Service. Although the range of butterfat production per cow was not so great as to bring out the character of the efficiency curve, which was made possible by the earlier study, the average feed requirement per pound of butterfat for cows producing between 300 and 400 pounds of butterfat per year, was almost exactly the same as was determined in the earlier study. The results of the analysis of these two cost of production studies with respect to feed requirements per 100 pounds of butterfat for cows of different butterfat producing power is shown in Figure 2 of Plate XXXVIII. It must be remembered that these feed requirements are not only for the dairy cow herself, but represent in addition to her maintenance and the feed required to produce the butter and butterfat contained therein, feed requirements for other animals in the dairy herd. These animals are either by-products of the herd or are necessary to its maintenance. A certain quantity of feed is consumed in increasing the number of dairy cattle to meet the increasing demand for dairy products.

Estimates of feed requirements based upon the results of this analysis shown in Table 42, and the average production per cow for the different years shown in Figure 1 of Plate XXXVIII, previously referred to, have been used to estimate feed requirements per 100 pounds of butterfat for the different years during the past three decades. On the basis of these feed requirements per 100 pounds of butterfat, the feed

Plate XXXVII

TRENDS OF BUTTERFAT PRODUCTION AND OF THOSE PORTIONS OF THAT PRODUCTION USED IN IMPORTABLE AND NON-IMPORTABLE PRODUCTS

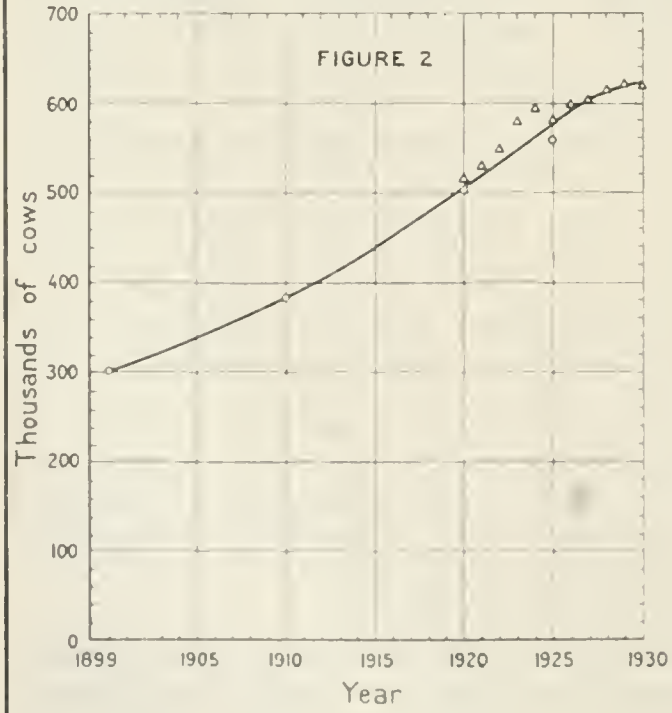


LEGEND

This chart is based on table (41) and consists of the following curves:

1 Consumption of market milk, cream, ice cream, butter and cheese. (Butterfat content)
2 Total production of butterfat. Estimates from original sources are shown thus: ○
3 Consumption of butterfat in cheese and butter.
4 Production of butterfat in butter, cheese, and condensed and evaporated milk. Estimates derived from original sources are shown thus: △
5 Production of butterfat in cheese and butter.
6 Production of butterfat in market milk, cream, ice cream and miscellaneous products. Based upon the difference between curves 2 and 4. Differences between estimates based on original sources are shown thus: □

TRENDS IN THE NUMBER OF COWS TWO YEARS OLD AND OVER KEPT FOR MILK IN CALIFORNIA



This chart is based on the following sets of data:

1 From the United States Census are shown thus: ○

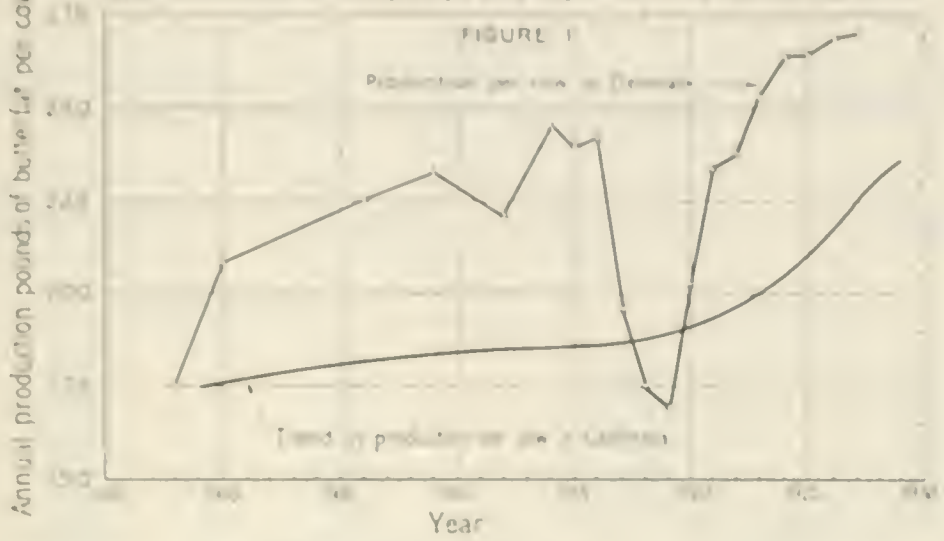
Year	Cows and heifers two years old and over kept for milk.
1900	307,245
1910	382,000
1920	502,415
1930	557,268

2 From the Monthly Supplements of "Crops and Markets." United States Department of Agriculture shown thus: △

Year	Cows and heifers two years old and over kept for milk.
1920	515,000
1921	530,000
1922	550,000
1923	580,000
1924	595,000
1925	579,000
1926	596,000
1927	602,000
1928	614,000
1929	626,000
1930	626,000

Plate XXXVIII

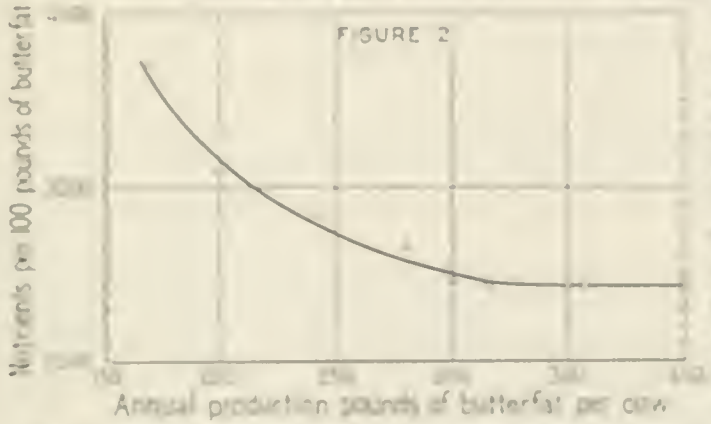
TREND OF BUTTERFAT PRODUCTION PER COW IN CALIFORNIA AND BUTTERFAT PRODUCTION PER COW IN DENMARK



Butterfat production per cow

In California		In Denmark			
Year	Production	Year	Production	Year	Production

AVERAGE WEIGHT OF DIGESTIBLE NUTRIENTS IN FEED REQUIRED TO PRODUCE 100 POUNDS OF BUTTERFAT FOR COWS PRODUCING DIFFERENT AMOUNTS OF BUTTERFAT ANNUALLY



LEGEND

requirements for the total California production of dairy products has been estimated. Estimates have also been made as to the feed requirements for the production of the importable and non-importable portions of that total. The results of these determinations are shown in Table 43.

TABLE 42

AVERAGE WEIGHT OF DIGESTIBLE NUTRIENTS IN FOOD REQUIRED TO PRODUCE 100 POUNDS OF BUTTERFAT FOR COWS PRODUCING DIFFERENT AMOUNTS OF BUTTERFAT ANNUALLY

Average butterfat produced per cow	Pounds of nutrients per 100 pounds butterfat	Average butterfat produced per cow	Pounds of nutrients per 100 pounds butterfat
1922 investigation		Values read from curve[1]	
171	3,700	180	3,440
200	3,080	200	3,180
242	2,820	220	2,980
280	2,660	240	2,820
315	2,420	260	2,670
357	2,430	280	2,570
400	2,450	300	2,490
		320	2,450
		340	2,430
1928 investigation		360	2,420
		380	2,430
		400	2,450
300	2,460		
350	2,440		
400	2,500		

[1] From Figure 2 of Plate XXXVIII.

Estimated Future Feed Requirements for the Production of California Dairy Products.

In Chapter V the probable future per capita consumption of dairy products was discussed. The conclusion developed was that present per capita consumption was probably as safe an estimate to use for future estimates as any other figure which might be used. Our problem, however, is not to determine the land area needed for the future production of all the dairy products consumed in California, but to determine the probable proportion of that consumption that is to be derived from California soil. It was with this objective in mind that the production of dairy products, as shown in Figure 1 of Plate XXXVII, was divided into two portions, one of these parts including those products easily imported from other parts of the country, such as butter, cheese and condensed milk, the other part including those products which can be imported only with unusual difficulty and cost. This last group includes market milk, cream and ice cream. In all of these estimates the production has been reduced to a butterfat content basis.

Even with these separated into importable and non-importable groups the problem of predicting years in advance what the trend is likely to be is not an easy one, because of the multitude of circumstances which may control shipments of dairy products from other parts of the country into California and the competition of crops supporting the dairy industry with other crops for the use of land. The approximations made, however, are premised upon the population estimates made in Chapter III and summarized in Table 13, and upon the assump-

tion that *the non-importable dairy products, together with the production of fruits and vegetables, will have first choice of the available lands up to the point that the demand for these products shall be fulfilled*. This, of course, is not a definite point, because price conditions enter to complicate any attempt to determine the point at which this demand may be satisfied. Here again, normal trend in demand must be a guide as to the probable future needs. After these needs

TABLE 43

FEED REQUIREMENTS IN DIGESTIBLE NUTRIENTS FOR CALIFORNIA BUTTERFAT PRODUCTION, 1899-1929

In millions of pounds

Year	1 Butterfat production per cow	2 Nutrients required per 100 pounds butterfat	3 Butterfat production	4 Nutrients required for state production
	Required to produce butterfat in all dairy products			
1899	174	3,560	51.5	1,833
1909	183	3,400	69.5	2,363
1919	188	3,330	92.5	3,080
1929	207	2,840	148.5	4,217
	Required to produce butterfat in non-importable dairy products[1]			
1899	174	3,560	23.5	836
1909	183	3,400	28.0	942
1919	188	3,430	33.5	1,116
1929	207	2,840	72.5	2,059
	Required to produce butterfat in importable dairy products[2]			
1899	174	3,560	29.0	1,032
1909	183	3,400	42.5	1,455
1919	188	3,430	60.0	1,958
1929	207	2,840	76.0	2,158

[1] Milk, cream, ice cream, etc. These products are not strictly non-importable but are usually produced near the point of consumption.

[2] Cheese, cheese, condensed milk, etc.

Sources of data and basis of estimate:

Items in column 1 are from Figure 1 of Plate XXXVIII.

Items in column 2 are from Figure 2 of Plate XXXVIII and Table 42.

Items in column 3 are from Figure 1 of Plate XXXVII.

Items in column 4 are determined by multiplying together the items on the same line in columns 2 and column 3.

have been met, land will be available for the production of miscellaneous field crops and importable dairy products. Future feed requirements for the California dairy industry will lie somewhere between that needed for the non-importable products and that needed to provide the present per capita production for future population growth. Just where this will come will be governed, as has been said, by a number of considerations, a very important, and probably a controlling one, being that lands adapted to the production of crops needed for the support of the dairy industry be available at reasonable costs of development. The estimates made of future feed requirements for the dairy industry, expressed in terms of digestible nutrients, are given in Table 44.

TABLE 44

ESTIMATED FUTURE FEED REQUIREMENTS FOR THE PRODUCTION OF CALIFORNIA DAIRY PRODUCTS

In millions of pounds of digestible nutrients

Year	For total butterfat production			For production on non-importable products		
	Roughage and pasture	Concentrates	Total	Roughage and pasture	Concentrates	Total
	Based on "reasonable lower limit" of population growth					
1930	3,375	1,000	4,375	1,725	500	2,225
1940	4,050	2,225	6,275	2,050	1,100	3,150
1950	4,725	3,425	8,150	2,375	1,700	4,075
1960	5,425	4,650	10,075	2,700	2,325	5,025
1970	6,100	5,875	11,975	3,050	2,925	5,975
	Based on "reasonable upper limit" of population growth					
1930	3,400	1,050	4,450	1,700	525	2,225
1940	4,375	2,575	6,950	2,225	1,275	3,500
1950	5,400	4,100	9,500	2,675	2,000	4,675
1960	6,400	5,625	12,025	3,175	2,750	5,925
1970	7,400	7,175	14,575	3,650	3,500	7,150

Basis of estimates:

The procedure that has been adopted in deriving the above estimates has been to determine feed requirements to the production of non-importable dairy products for the two intermediate estimates of population given in Table 13, it being assumed that the minimum land requirements will be for the production of non-importable products to support a population estimated at the "reasonable lower limit." This estimated feed requirement has been divided into two portions for present consideration including nutrients in concentrates in one and nutrients in roughage, to be derived from hay and pasture, in the other. This division has been made on the assumption that in 1970 the market milk supply will be provided by cows using the minimum roughage requirement. (This is approximately 15 pounds per cow. This becomes about 20 pounds per cow giving milk when other animals in the herd are provided for). It has also been assumed that in 1975 the average butterfat production per cow will have reached 275 pounds per cow. This assumption is based upon the production per cow in Denmark, shown in Figure 1 of Plate XXXVIII. Production per cow in Denmark has been derived from data given in: Pirtle, T. R., History of Dairying, page 277; and Statistisk Aarbog, page 43, 1929. The same calculation has been made for total production of dairy products on the basis of present per capita production. This is somewhat less than present per capita consumption, but, inasmuch as the trend in the proportion of total consumption provided by California dairies is downward, present per capita production is probably higher than will be reached at any future time.

THE BEEF CATTLE INDUSTRY

The determination of the land requirements for the beef cattle industry involves a consideration of beef and veal supplies from various sources. Approximately 24 per cent by weight of our beef and veal slaughter comes from the California dairy industry, another 15 per cent is imported for immediate slaughter. California produced beef, exclusive of feeders and the supply coming from the dairy industry, comprises only 17 per cent of the total, while feeders raised in other states and fattened in California comprise 44 per cent. California feed contributes in the production of beef from these feeders about 56 per cent of their total weight when slaughtered. Considering beef and veal supplies from the dairy industry, from the California beef breeding herds and from the proportion contributed by California feed to the fattening of imported feeders, the state produces on its own lands about 41 per cent of its beef and veal supply. An estimate has been made of the feed requirements for producing the supplies from these different sources to make possible determinations of amounts and kinds of land required in California. Feed requirements for producing the meat supplies contributed by the dairy industry are inseparable

from the feed supplies required for producing all dairy products. For our purpose, however, it is unnecessary to make this separation.

Feed Requirements for California Beef Breeding Herds.

The number of pounds of digestible nutrients required to produce that portion of the slaughter coming from the California breeding herds have been estimated on the basis of known herd compositions by age and weight, to which known feed requirements have been applied for the determination of total number of pounds of digestible nutrients required to produce a pound of beef. The results of this analysis are shown in Table 45 and in Figure 1 of Plate XXXIX. Including requirements for the maintenance of the breeding herd, it requires 23.48 pounds of digestible nutrients per pound of veal produced, based on the live weight of a calf at the end of its first nine months. By the time a yearling has reached the end of his second year it has required for herd maintenance and for his own two years' growth 18.8 pounds of digestible nutrients in feed per pound of beef (live weight). The two-year-old has required the expenditure of a still smaller amount per pound, averaging 17.9 pounds of nutrients in feed for each pound of beef, but from here on the average feed requirement increases and at the end of the fourth year it has taken an average of 20.1 pounds of feed nutrients to produce each pound of beef. These estimates, applied to the total number of cattle in California, after deductions have been made for feeders, dairy cattle, and net shipments into the state for immediate slaughter, have been the basis of estimating total feed requirements for that portion of beef supplies coming from California breeding herds. The results of these estimates are shown in Table 46.

This table also shows feed requirements for feeder cattle after importation, which, added to the estimates of requirements for the California beef breeding herds, gives us a figure for total feed supplied from California soils to the production of California beef slaughter. These estimates have only been made for the past six years. Approximations have been made for 1922 and 1923 for use in preparing the agricultural index presented graphically in Plate III and Table 1B of Appendix B to this report. There are so many gaps in statistics for the years prior to 1922 that estimates of numbers imported as feeders and for immediate slaughter have been impossible by direct means.

These detailed estimates for this short period have been very useful in estimating, by indirect methods, the feed requirements for the live stock industry over the past two decades. Numbers of live stock of different ages, acreage of crop land used for producing feed, trends in the acreages of forest, woodland and grassland pasture, and estimates of carrying capacity have, together with the data in Table 46, furnished the means of projecting these estimates back to the earlier period. Carrying capacities, however, have not been given as much weight in these calculations as have the other elements. They have been used in weighing the importance of the different kinds of pasture. Table 47 contains the estimates of California beef slaughter subdivided into the portions coming from different sources. The figures given in this table have formed, together with Table 45 and Figure 1 of Plate XXXIX, the basis of the estimates given in Table 46. The estimates for the past 20 years are reserved for discussion with the

TABLE 45

POUNDS OF DIGESTIBLE NUTRIENTS REQUIRED TO PRODUCE A POUND, LIVE WEIGHT, OF CALIFORNIA BEEF

	Nutrients required per head			
	Calves	Yearlings	Twos	Threes
First year	10,024	10,024	10,024	10,024
Second year	----------	3,333	3,333	3,333
Third year	----------	----------	4,609	4,609
Fourth year	----------	----------	----------	5,412
Total nutrients required per head	10,024	13,357	17,966	23,378
Average weight at end of year	427	711	1,005	1,162
Average nutrients required per pound of beef	23.48	18.79	17.88	20.12

Sources of data and bases of estimates:

Computation of the number of pounds of digestible nutrients to produce a pound of beef (live weight) is based on original field notes on 25 out of 32 California beef cattle herds studied by Professor R. L. Adams in 1922 and 1923, and summarized in: Adams, R. L., The Results of a Survey to Determine the Cost of Producing Beef in California. California Agr. Exp. Sta. Cir. 281, page 25, Dec., 1924. Nutrient requirements from Henry, W. A., and F. B. Morrison, Feeds and Feeding, Eighteenth edition. The Henry-Morrison Company, 1922. Appendix, Table V, Morrison, Feeding Standards, page 746.

Computation of feed requirements for calves (including maintenance of cows and bulls) has been made, using the results of various investigations supported by data in the field notes referred to above, which show that the nutrient requirements per cow, including calves and bulls, approximate that of two yearlings. The nutrient requirements for a yearling are then doubled and multiplied by the number of cows in the aggregate herd in the above study to get the nutrient requirements for all calves, cows and bulls. This figure is divided by the number of calves in the herd to determine the pounds of digestible nutrients per calf. To this figure, 3 per cent is added to take care of mortality of calves, cows, and bulls during the year. For yearlings, Morrison's Feeding Standards were used and the average weight in the herds studied and 2.21 per cent was added for mortality. For two- and three-year-olds nutrient requirements were determined in the same manner as for yearlings, 1.28 per cent being added for mortality of two-year-olds and 1.33 per cent for mortality of three-year-olds.

TABLE 46

ESTIMATED FEED REQUIREMENTS FOR CALIFORNIA BEEF SLAUGHTER, EXCLUSIVE OF SLUGHTER FROM DAIRY HERDS, 1924-1929

Expressed in terms of millions of pounds of digestible nutrients fed within and outside of California

Year	Within California			Other states			7
	1 California beef herds	2 Feeders after importation	3 Total within California	4 Net imports for immediate slaughter	5 Feeders before importation	6 Total out of California	Total requirements for California slaughter
1924	2,852	2,033	4,885	3,381	3,608	6,989	11,874
1925	3,193	2,273	5,466	2,805	4,033	6,838	12,304
1926	1,835	2,675	4,510	2,947	4,746	7,693	12,203
1927	1,827	2,895	4,722	2,021	5,136	7,157	11,879
1928	1,483	3,011	4,494	1,786	5,343	7,129	11,623
1929	2,096	2,590	4,686	1,235	4,596	5,831	10,517
Per cent of total	19	22	41	20	39	59	100

Sources of data and bases of estimates:

Column 1 is based upon the live weight of slaughtered beeves, from which is deducted 22 per cent for stock cows and bulls slaughtered. The remainder is multiplied by 17.88, the pounds of digestible nutrients required to produce one pound of beef. This factor is based upon Table 45 and Plate XXXIX, and the average age and weight of slaughtered steers. This column includes a small percentage of veal, which is a residual after deducting veal slaughter contributed by California dairy herds and calves imported for slaughter. Feed requirements for these include the feed for the cow and calf during the gestation period and life of the calf, and also a proportionate part of the feed requirements for the breeding herd during the same period. It is estimated that 19.94 pounds of digestible nutrients are required per pound of veal slaughter.

Columns 2 and 5 are based upon Table 47, and estimates of the ages of steers at the time of their shipment into the state and at the time of their slaughter.

Column 3 equals column 1 plus column 2.

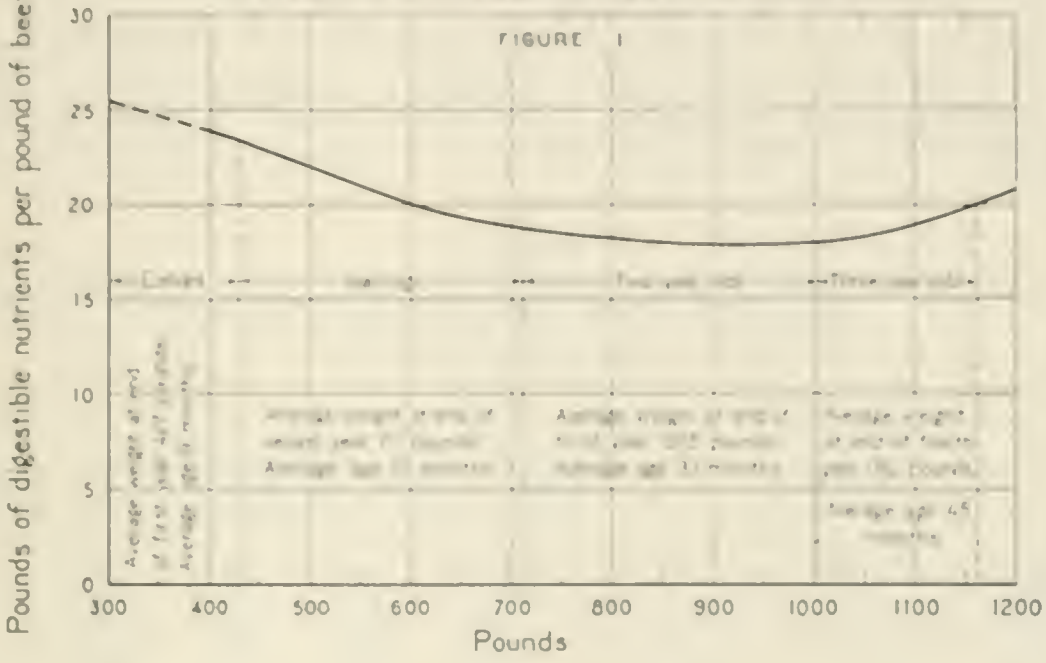
Column 4 is based upon slaughter of imported beef in Table 47 multiplied by 17.88, the estimated number of pounds of nutrients required per pound of beef in Plate XXXIX and Table 45.

Column 6 equals column 4 plus column 5.

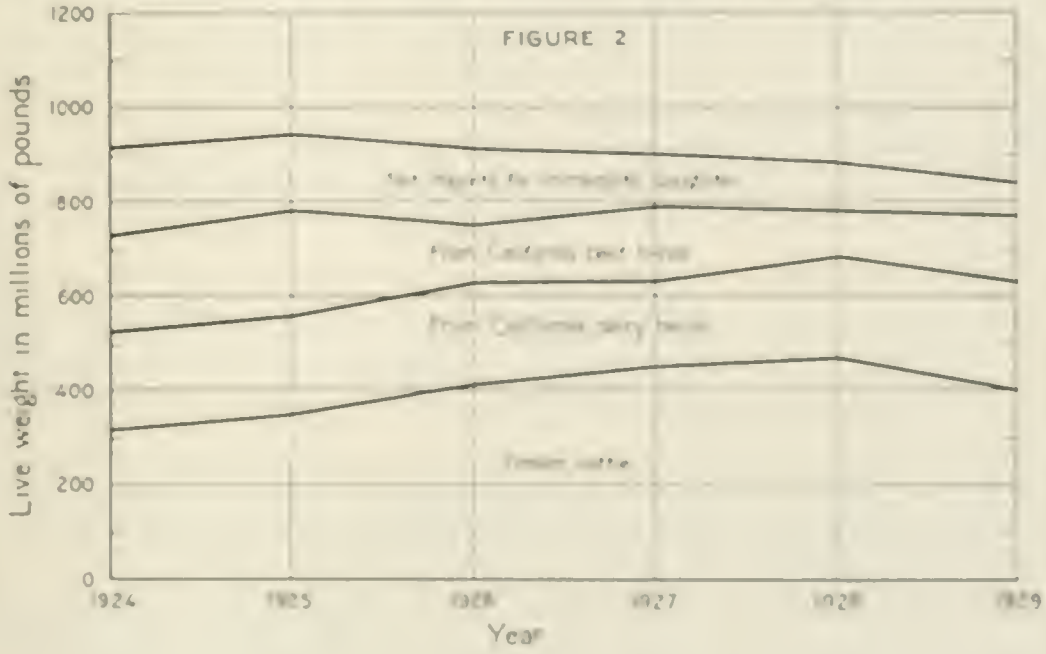
Column 7 equals column 3 plus column 6.

Plate XXXIX

POUNDS OF DIGESTIBLE NUTRIENTS REQUIRED TO PRODUCE A POUND OF BEEF IN CALIFORNIA



ESTIMATED CALIFORNIA BEEF SLAUGHTER SHOWING APPROXIMATE DISTRIBUTION WITH RESPECT TO SOURCE OF SUPPLY



other live stock enterprises and are presented in Table 61. The portions of California beef slaughter coming from different sources are shown graphically in Figure 2 of Plate XXXIX. It will be seen that the increase in the feeder-cattle business is the answer to why total feed requirements for California produced beef has increased so slowly in proportion to the population. It is primarily because *California is drawing a larger and larger part of its total slaughter from adjoining states, in which the producing herds are fed, while the California grasslands are being reserved more and more for the finishing of these imported beeves for market.* By far the greater part of the beef-cattle-feeding enterprises are either in or adjacent to the San Joaquin Valley.

TABLE 47

ESTIMATED CALIFORNIA BEEF SLAUGHTER BY WEIGHT AND ITS DISTRIBUTION WITH RESPECT TO SOURCE OF SUPPLY, 1924-1929

Live weight in millions of pounds

Year	1 California beef herds	2 California dairy herds	3 Net imports for immediate slaughter	4 Imported feeders	5 Total slaughter
1924	202	214	188	314	918
1925	226	208	155	351	940
1926	126	216	164	413	919
1927	126	216	112	447	901
1928	101	218	99	465	883
1929	144	226	69	400	839

Sources of data and bases of estimate:

Column 1 is based upon herd composition by age groups, average age of discarded cows and bulls, average age at which steers are sold, per cent in number of aggregate herd slaughtered each year. All of these were obtained by an analysis of the original field notes compiled by Professor R. L. Adams in the determination of the cost of producing beef in California. The results of this survey are summarized in the following publication: Adams, R. L., The Results of a Survey to Determine the Cost of Producing Beef in California. California Agr. Exp. Sta. Cir. 281, page 25, Dec., 1924. Numbers of cattle in California beef breeding herds were based upon estimates of numbers of "all cattle" and numbers of cows kept for milk, two years old and over, obtained from U. S. Dept. of Agr. Bur. of Agr. Economics, Crops and Markets. Monthly supplements. Data for the years 1924-26 were obtained from Vol. 3 Supplement 2, Feb., 1926, pages 38-39, and for the years 1926-29, from Vol. 6, No. 2, Feb., 1929, pages 39-40. Numbers of other dairy cattle were based upon estimates of compositions of dairy herds supplied by Geo. A. Scott, Live stock Statistician, U. S. Dept. of Agr., Bur of Agr. Economics, Regional Live stock Office, Sacramento, California. Average weights of animals slaughtered were based upon numbers and weights of cattle slaughtered in California in 1909, 1914, 1919, 1921, 1923, 1925 and 1927, obtained from U. S. Dept. of Com., Bur. of the Census, Census of Manufactures, Section on Slaughtering and Meat Packing, 1924, 1926, 1928. This column contains a small percentage of veal slaughter, estimated on the basis of total veal slaughter, from which has been subtracted imported veal for slaughter and estimated veal slaughter contributed by California dairy herds.

Column 2 is based upon estimates of numbers of cows two years old and over kept for milk, as determined for estimates in column 1. Calf slaughter, contributed by the dairy herd, was estimated on a basis suggested by R. M. Hagan, Managing Director of the Western Cattle Marketing Association. This method assumes that 90 per cent of the cows kept for milk will produce a calf each year, half of which will be steer calves. Of these, 10 per cent will not be raised or sold and 20 per cent of the remainder will be grown for beef. A sufficient number of the heifer calves will be raised to replace one-seventh of the number of dairy cows each year; the remainder will be sold for veal. These added to the steer calves, estimated on the above basis, comprise the total number of dairy calves available for veal. Average weights were determined as in column 1. Of the dairy cows, one-seventh of the number are slaughtered each year, also one-fifth of the number of bulls are slaughtered each year.

Column 3. Net imports for immediate slaughter were compiled from monthly reports issued by the California Protective Service.

Column 4. Information regarding numbers of feeder cattle shipped into California each year was supplied by the Western Cattle Marketing Association. It is estimated that approximately all the feeders shipped into the state in any year, less about 3 per cent mortality loss, will normally be slaughtered during the following year.

Column 5 is the sum of columns 1, 2, 3 and 4.

The methods described above, so far as the slaughter of beeves is concerned, gives an estimate of the amount of beeves available for slaughter, which does not coincide exactly with estimates of actual slaughter for any one year but which approximates estimates of slaughter over a longer period of time. The difference in any one year between beef available for slaughter and the estimated slaughter represents either excess draft upon breeding herds resulting in their depletion, or the reverse, resulting in their increase. This annual difference between beeves available for slaughter and beeves actually slaughtered was prorated between the slaughter from California beef herds and feeders to get the estimated slaughter from each source, assuming that the slaughter from dairy herds is not affected to such a great extent by the same influences controlling the movement of beeves to market.

The following publication has been of great value in indicating sources of material and the elements which were necessary to consider in making these estimates: Voorhies, E. C., Economic Aspects of the Beef Cattle Industry. California Agr. Exp. Sta. Bul. 461, November, 1928.

Beef Cattle and Irrigation.

Of particular interest from the standpoint of irrigation is the 4.2 per cent which, during the past six years, represents the ratio of supplementary feeds to total feed used in the production of California beef. This is exclusive of the requirements for producing the beef supplied by the dairy industry. Although small in amount, this 4 per cent, when combined with requirements for supplementary feed used by other live stock, is an important item. The growth of the feeder industry is bringing about an increase in this percentage. Of importance also when these items are all brought together, are the estimates given in Table 48 of feed supplied from the different sources. It will be seen that among the feeds used in addition to grass, the first group of importance includes the cottonseed products. These and hay form the bulk of supplementary feeds for production, while barley and miscellaneous concentrates make up the balance.

In considering the relation of irrigation to beef production, the large area of grassland flooded for pasture should be mentioned. Just what part these lands play in the beef supply has not been determined. There are some cases where the irrigated pasture supplements the foothill range, providing feed at a time of year when the foothills either are deficient in feed or must be protected to insure a future supply. It is a question whether the use of valuable irrigation water in the haphazard irrigation of these valley pastures is the most economical method of doing this. It is, however, a subject which is greatly in need of more thorough study.

TABLE 48

ESTIMATED SUPPLEMENTARY FEED REQUIREMENTS, 1922-1929, FOR CALIFORNIA PRODUCED BEEF, EXCLUSIVE OF SLAUGHTER FROM DAIRY HERDS

In millions of pounds

Year	Hay	Barley	Cottonseed cake and meal	Miscellaneous concentrates	Nutritive equivalent of supplementary feed	Per cent of total nutritive requirements
1922	85	9	84	9	179	3.4
1923	77	11	107	10	205	3.5
1924	92	13	120	11	232	3.9
1925	99	14	134	13	260	4.3
1926	93	15	137	13	259	4.4
1927	88	15	128	12	243	4.0
1928	87	15	131	12	245	4.2
1929	93	16	143	13	269	4.3

Sources of data and basis of estimates

Supplementary feed required for California breeding herds has been computed on the basis of units of different kinds of feed fed to all California beasts in 1925 and 1929, and computations made per pound of digestible nutrients in these feeds. The percentage of nutrient requirements thus determined for each type of feed were applied to total nutrients supplied for California beef herds shown in Appendix A, Table 46, 5.6 1924 etc., giving amounts of nutrients from each type of feed to maintain California beef herds. These estimates were then converted to pounds of feed. Table 49 and trends in the ratio of irrigated farm California breeding herds and slaughter of feeders to total California beef cattle population and the trend in numbers of cattle imported for immediate slaughter formed the basis of percentage total statewide ratios for beef breeding herds and feeders.

Estimates of supplementary feed requirements for farmed pastured for following

Above 50 per cent of all forage may be the range during the winter feeding period, while averages fifteen months. During the last 30 days they are fed on the average of 10 pounds of cottonseed cake per head per day. About 10 per cent of the feeders are fed on range for twelve months and then fattened in feed lot for 30 days on a ration consisting of approximately 11 per cent concentrates, 18 per cent alfalfa hay, 18 per cent grain hay, 40 per cent barley, 3 per cent cottonseed products and 4 per cent salt. On this basis of these estimates together with estimates of feeders and range steers not supplementary, supplementary feed requirements for feeders were computed. These estimates are the result of interviewing cattlemen, managers of feeding enterprises, agriculturists and specialists in animal husbandry.

Future Feed Requirements for Beef Production.

California per capita beef slaughter has decreased much more rapidly than United States per capita beef consumption, as may be seen in Table 49. California per capita slaughter has been much greater than United States per capita consumption, but this difference has been declining rapidly. This is evidence either of a more rapid decline of beef consumption in California than in the United States, an increase in the use of substitutes for California slaughtered beef, or a decrease in the shipments of California beef products out of the state. Any one of these would support the hypothesis that future growth of California beef production will depend upon the rate of improvement of our grazing resources, rather than upon the demand for beef which is likely to keep well in advance of that part of the supply produced in California; that supplementary feed requirements for the beef cattle industry will increase just to the extent that the improvement of grazing resources and importation of feeders will permit the expansion of the industry; and that past trends in feed utilized by the beef cattle industry are probably the best indications available of future trends, regardless of what the future California population may be. Table 50 shows that the live weight of beeves and calves slaughtered in California increased from 707 to 839 million pounds, or 18.6 per cent, in 20 years. Attention has been called to the fact that California population increased 138 per cent during that period.

It is estimated that feed utilized by beef cattle will increase at the rate of about 500 million pounds of nutrients per decade. This will bring the total requirement in 1970 up to about 6600 million pounds, 280 million of which will be hay, barley, cottonseed products and miscellaneous concentrates.

TABLE 49

ANNUAL PER CAPITA CONSUMPTION OF BEEF AND VEAL IN THE UNITED STATES, AND ANNUAL PER CAPITA SLAUGHTER OF BEEF AND VEAL IN CALIFORNIA, 1909-1929

In pounds per capita, dressed weight

Year	California slaughter	United States consumption	Year	California slaughter	United States consumption
1909	169.9	82.3	1920		70.7
1910		77.9	1921	110.9	63.9
1911		74.1	1922	118.3	67.7
1912		67.4	1923	122.6	69.1
1913		65.7	1924	123.4	69.8
1914	109.8	63.1	1925	120.7	70.9
1915		58.8	1926	112.1	71.8
1916		61.3	1927	103.7	65.8
1917		66.0	1928	96.3	58.5
1918		70.4	1929	86.6	58.2
1919	99.1	69.3			

Sources of data and bases of estimates:

United States per capita consumption from U. S. Dept. of Agr., Bur. of Agr. Economics, Statistics of Meat Production, Consumption and Foreign Trade of the United States, 1900-1929. Preliminary Report, Washington, D. C., April, 1930. Tables 3 and 4, pages 5 and 6.

California per capita slaughter based upon Table 50 and estimated California population.

TABLE 50

ESTIMATED CALIFORNIA BEEF CATTLE SLAUGHTER, NUMBERS AND LIVE WEIGHT, 1909-1929

Year	Thousands of animals		Live weight in millions of pounds		
	Steers	Calves	Steers	Calves	Total
1909	650	220	393	51	787
1910	694	199	394	43	547
1911	650	207	399	48	607
1912	667	259	587	64	721
1913	711	175	611	85	796
1914	771	417	671	93	867
1915	667	440	811	107	918
1916	693	454	856	104	960
1917	807	464	812	107	919
1918	738	451	765	104	869
1919	752	441	760	101	861
1920	794	417	774	100	874

Sources of data and bases of estimate:

Numbers of animals 1924-1929 are estimates of Grace L. Smith, University of California, U. S. Dept. of Agr. Bur. of Agr. Economics, Berkeley, and other agricultural statistics, California. From 1909 to 1923, inclusive, numbers of animals are based upon the ratio between estimates of meat, 1924-29, and records of the California Cattle Protective Service for the same period applied to the reports of the meat agency for the years 1909 to 1923, inclusive. The 1.08 quarter are for inspected total slaughter of the United States for two years by Government Bureaus. This was a special report and has not been repeated since that time. The slaughter figures reported every two years by the Census of Manufactures from 1909 to 1919 and every five years since 1919 apparently underestimate the number of wholesale establishments engaged in wholesale slaughtering and meat packing. The County Production Service figures are from California Department of Agriculture reports on slaughter in the different counties, including a number of the counties on farms and ranches and to private establishments. The estimates of losses, use for local slaughter, and move out from the data furnished by the Cattle Protective Service. From the above records the trend in the ratio of slaughter on farms and ranches and on other establishments to total slaughter from 1909 to 1929 was determined. With these trend ratios for 1914 and 1919 and the data from the Census of Manufactures, total slaughter for these years was computed.

THE SHEEP INDUSTRY

Although there is an upward trend in the total amount of supplementary feed required for the production of lamb, mutton and wool, there has been a downward trend since 1922 in the percentage in the total nutrient requirements supplied by supplementary feeds. In 1922 it is estimated that 6.7 per cent of the total feed required for the sheep industry in California was in the form of alfalfa meal and hay, barley and cottonseed cake, while in 1929 it is estimated that only 5.4 per cent of the total feeds for the sheep industry were provided from these sources. These estimates have been made on the basis of rations fed by several California producers and the estimated number of sheep and lambs produced in California and of those shipped into California.

During the period 1922 to 1929 there was rather wide variation in the number of sheep brought in from other states, there being a gradual reduction in the number since 1924. During the same period the proportion of California produced sheep increased very greatly. It is the changes in these proportions which account for the changes in the percentage of supplementary feed used. That this trend has continued over a much longer period than the eight years under which detailed information can be obtained is suggested by the trend in number of sheep in California already shown in Plate XXXVI.

Undue weight should not be given to the changes shown in this short period. The possibility of wide variation is indicated by the deviations from the average for these eight years. The average for the eight-year period nevertheless gives us a basis of estimating what part of the

total feed requirements for the sheep industry during recent years has been provided by crops grown, in part at least, under irrigation. From 1922 to 1928 the average supplementary feeds used per year, in addition to pasture, have been estimated at 126 million pounds. As in the case of beef cattle the greater part of this was cottonseed products, but more than a third was supplied by alfalfa hay. Barley made up most of the balance. Although only 5.75 per cent of the total feed requirements of the sheep industry, it is an item which should be considered along with the others. The detailed estimates of feed requirements from 1922 to 1929 are given in Table 51. The estimates of the number and weight of sheep and lambs slaughtered in California and the division of these into that part which has been produced in California and that part shipped in are given in Table 52. The items in this table have formed an important element in the calculations of feed requirements for the California-produced lamb and mutton given in Table 51, which in turn have been projected back to 1909 on the basis of number of animals and the ratio of lambs to sheep. It is believed that taking account of the trend in this ratio has largely accounted for most of the increased output per pound of feed used in the sheep industry. The trend in estimated feed requirements for the sheep industry over a period of two decades is given in Table 61, with the estimates for other live stock.

TABLE 51

ESTIMATED SUPPLEMENTARY FEED REQUIREMENTS FOR CALIFORNIA-PRODUCED LAMB AND MUTTON, 1922-1929

In millions of pounds

Year	Alfalfa Meal	Alfalfa Hay	Barley	Cottonseed cake	Nutrients in supplementary feed	Per cent of total nutrient requirements
1922	34	17	23	85	113	6.7
1923	34	17	23	89	116	6.5
1924	34	17	22	98	121	6.0
1925	32	16	21	100	121	5.7
1926	33	17	22	109	129	5.9
1927	33	16	22	109	128	5.7
1928	34	17	22	120	139	5.8
1929	35	17	23	121	141	5.4

Sources of data and bases of estimates:

On the basis of information supplied by managers of commercial feed lots, specialists in animal husbandry, agricultural economists and county farm advisors, the following estimates were made:

Of the total lamb slaughter, 25 per cent, which is 23 per cent of the total number of sheep and lambs slaughtered, are fattened in commercial feed lots for 60 days on the following ration:

Alfalfa meal	1.39 pounds per day per head
Alfalfa hay	0.70 pounds per day per head
Barley	0.92 pounds per day per head
Cottonseed cake	0.54 pounds per day per head
Total	3.55 pounds per day per head

The remainder of the lambs are fed entirely on grass. Ewes in lamb are fed three-quarter pounds of cottonseed meal per head per day for a period of 60 days. All other feeding is on pasture. Lambs average 60 pounds in weight, sheep 150 pounds. Lambs are marketed at average age of five months and are weaned at about four months. By this time they are grazing regularly beside dams, therefore the average feeding period for lambs on grass is estimated at two months. On the basis of the above estimates, and nutrient requirements from Henry and Morrison (Henry, W. A. and F. B. Morrison. Feeds and Feeding. Appendix. Table 5, pages 744-748), feed requirements were estimated in terms of digestible nutrients and also in terms of different kinds of feed.

TABLE 52

ESTIMATED SLAUGHTER OF CALIFORNIA-PRODUCED SHEEP AND LAMBS, 1922-1929

Year	Number of sheep and lambs (in thousands)			Live weight of California-produced sheep and lambs slaughtered (thousands of pounds)
	Total	Shipments into California	California-produced	
1922	1,777	124	1,653	158,244
1923	1,775	128	1,647	157,774
1924	1,735	175	1,560	167,084
1925	1,687	102	1,585	170,451
1926	1,725	234	1,491	116,418
1927	1,701	106	1,595	124,823
1928	1,732	74	1,677	126,124
1929	1,802	58	1,744	134,288

Sources of data and bases of estimates:

Estimated total slaughter 1922, 1923 and 1924 based upon San Francisco and Los Angeles reported slaughter and ratio of these to total slaughter for 1925 to 1929. Data see Grace Woodman, Edwin C. and W. E. Schroeder, Economic Aspects of the Sheep Industry, California Agr. Exp. Sta. Bul. 475: 44-47, Tables 20 and 21. Net shipments into California based upon shipments into and out of California supplied by California Wool Growers' Association.

Future Feed Requirements for Sheep.

The ratio of California per capita slaughter to United States per capita consumption of lamb and mutton has declined as in the case of beef. Table 53 shows that California per capita slaughter has declined nearly 30 per cent in eight years, while United States per capita consumption has increased somewhat. Although the eastern market may be to some extent involved in this trend, it is probable existing feed resources in the long run will control the expansion of the sheep industry. The carrying capacity of our ranges are subject to improvement and there is still considerable waste forage on farms which may be utilized in increasing the feed available for the production of lamb and mutton.

It is assumed, therefore, that the sheep industry will probably be able to expand its use of feed at the rate of 425 million pounds of nutrients per decade, which is about the average rate of increase for the past 20 years. This would give a total requirement of a little more than 4200 million pounds of nutrients for the sheep industry in 1970. This seems conservative in the light of increasing United States

TABLE 53

ANNUAL PER CAPITA CONSUMPTION OF LAMB AND MUTTON IN THE UNITED STATES, AND ANNUAL PER CAPITA LAMB AND MUTTON SLAUGHTER IN CALIFORNIA, 1922-1929

In pounds per capita, dressed weight

Year	California slaughter	United States consumption	Year	California slaughter	United States consumption
1922	16.1	5.0	1926	14.0	5.5
1923	17.2	5.0	1927	14.5	5.4
1924	15.1	5.2	1928	13.1	5.5
1925	14.7	5.2	1929	12.9	5.5

Sources of data and bases of estimates:

United States per capita consumption from U. S. Dept. of Agr., Bur. of Agr. Economics, Statistics of Meat Production, Consumption and Foreign Trade of the United States, 1909-1928. Preliminary Report, April 1930, Table I, page 3.

California per capita slaughter based upon Table 52 and estimated California population.

per capita consumption of lamb and the relatively large part of the product of the California sheep industry consumed in this state. The slow growth of the beef cattle industry, which probably will continue in the future, may stimulate increased consumption of lamb. Of the 4200 million pounds of nutrients estimated to be required by the sheep industry in 1970, about 241 million pounds will be in the form of alfalfa, barley and cottonseed cake. The balance will be derived from pasture.

THE SWINE INDUSTRY

We have seen in Plate XXXVI that the numbers of California swine have been declining during the past 13 or 14 years. Estimates of pork slaughter, on the other hand, have not followed this same trend. This is in part due to increased shipments into California, but increased production in proportion to the numbers of hogs has also been in evidence. In the production of pork, as in the case of dairy products, there has been a remarkable change with respect to feed requirements per pound of product. The extent of this change is not so easily measured as in the case of the dairy industry. At the same time increased production has been indicated in the statistics, and there has been a very rapid increase in the number of inspected slaughtering establishments. As a result, a much larger percentage of the total slaughter is represented in available statistics of known slaughter.

On the basis of available California statistics, the increased production per hog on farms has been out of proportion to any rational estimate of increased production. From the records of such meager data as are available on the feeding of hogs in California, it appears that the important element in the lower feed requirement seems to be the reduced length of time required to bring the hog to the weight required for market. In fact, in the few cases available for analysis, low feed requirements per pound of pork produced, small numbers of hogs in the herd relative to pork production and a consequent large output per hog in the herd are associated with a smaller production in pounds of pork per sow in the herd.

Regardless of the cause of the reduced feed requirements per unit of product and notwithstanding the possibility of errors in the statistics, which obscure the true trend in the amount of feed used per pound of pork, the estimates made for the eight years from 1922 to 1929 probably give a fairly good approximation as to feed requirements.* These data, given in Table 54, also provide a starting point from which trends in feed requirements have been projected back on the basis of hog population. In addition, they give an indication of feed requirements per pound of pork that is useful in looking forward to the future demand for feed on the basis of the probable trend in the human population. Table 55 gives the separation of the California hog slaughter into that produced in California and that shipped in. It is this table that has made possible the estimates in Table 54.

* The limitations of the data must be recognized, however, in any attempt to interpret them as an index of the trend in feed requirements. To determine the trend in the amount of feed per pound of pork it is believed that, in the light of what has just been said concerning the output of pork in relation to number of hogs in the herd, the number of hogs in the state constitutes the best index available. Average weights of hogs slaughtered have not changed greatly. The role the detailed estimates from 1922 to 1928 play is in separating California produced swine slaughtered from total California swine slaughter.

TABLE 54

ESTIMATED FEED REQUIREMENTS, OTHER THAN PASTURE AND GARBAGE, FOR CALIFORNIA-PRODUCED PORK, 1922-1929

In millions of pounds

Year	Barley	Raisins or other dried fruits	Milk	Hay	Other feeds	Digestible nutrients[1]
1922	388	114	108	11	13	409
1923	340	100	95	10	11	370
1924	307	90	85	9	10	324
1925	268	78	75	8	9	283
1926	250	74	70	7	8	265
1927	314	92	88	9	10	330
1928	380	112	107	11	12	403
1929	400	117	112	11	13	421

[1] This is about 87 per cent of the total nutrients required, approximately 22 per cent being supplied by pasture and 11 per cent by garbage.

Sources of data and bases of estimates:

Information on feed requirements for hog production in California is very limited. It was found, however, from consulting enterprises raising and feeding swine in the San Francisco Bay district that hogs in that area are fed almost entirely on garbage. On the basis of this information, it was estimated that all swine in the predominantly urban counties (Los Angeles, Orange, San Francisco, Alameda, Contra Costa, Marin, and San Mateo) are fed on about 90 per cent garbage and 10 per cent grain, in terms of digestible nutrients. Data obtained from a study of hog feeding in Kings County, together with information from farm advisers in the San Joaquin and Sacramento valleys and a consideration of garbage fed in cities, such as Sacramento and San Diego, located in rural counties, made it possible to determine approximate feed rations. See Sullivan, Watson, and Hilbert, L. W., Swine Swine Enterprise Efficiency Study, Kings County, California. Agricultural Extension Service of the University of California and U. S. Dept. of Agr., Mimeographed report. March 1, 1929 to February 28, 1930.

It was estimated that the following average ration was fed per pound of pork produced in the rural counties: 2.74 pounds of grain, 0.82 pounds of raisins or other dried fruit, 0.75 pounds of skimmed milk, 0.08 pounds of hay, 0.09 pounds of other feeds, 0.08 pounds of digestible nutrients from pasture, and 0.12 pounds from garbage. This is the equivalent of four pounds of digestible nutrients per pound of pork produced in the rural counties. It is presumed that the same amount of digestible nutrients per pound of pork will be required in the urban counties. This is apportioned as follows: 90 per cent from garbage and 10 per cent from grain, which is the equivalent of 3.6 pounds of digestible nutrients from garbage, and 0.40 pounds of digestible nutrients from grain (3.50 pounds of grain) per pound of pork produced in the urban counties. Slaughter for each year was segregated into that portion originating from the urban counties and that portion produced in the rural counties on the basis of the distribution of hog population as shown by the census. The rations outlined above were then applied to these slaughter figures to arrive at an estimate of requirements.

TABLE 55

ESTIMATED SLAUGHTER OF CALIFORNIA-PRODUCED SWINE, 1922-1929

Year	Numbers of swine in thousands			Live weight of California-produced swine slaughter, thousands of pounds
	Total	Shipments into California	California produced	
1922	1,310	472	838	152,516
1923	1,468	711	757	147,774
1924	1,399	915	484	101,848
1925	1,291	922	370	100,178
1926	1,188	846	342	95,844
1927	1,353	675	678	125,193
1928	1,041	813	828	150,696
1929	1,481	817	804	147,248

Sources of data and bases of estimates:

Estimated total slaughter for 1928-29 supplied by Geo. A. Hoag, Live stock statistician, U. S. Dept. of Agr., Sacramento, California; for 1927-28 increased by preserving given total hog population, and 1923 reported slaughter from Census of Manufactures, 1923. Average weight (382 pounds) computed from weights and numbers of California swine slaughtered from Census of Manufactures 1923, 1925, 1927 Slaughtering and Meat Packing. Imports are from Market News Service, U. S. Dept. of Agr., Bur. of Agr. Economics, cooperating with California Department of Agriculture, San Francisco, May 6, 1930.

Future Feed Requirements for Pork Production.

Although pork is produced at a lower expenditure of feed nutrients than any of the other important meats, the feed used, aside from garbage and by-products, is produced on crop lands, while the greater

part of the feed consumed by sheep and beef could be utilized in no other way. Increase in hog production in California will probably depend upon increased supplies of garbage and other by-products. It is doubtful if this increase will be such as to more than offset the more extensive use of these by-products. Table 56 shows a declining per capita slaughter for California with an increasing United States per capita consumption. Although the 400 million pounds of digestible nutrients in grain and eleven million pounds in hay may be exceeded, the error introduced by this industry is not a serious one, for no matter how accurately we might estimate future requirements, it is certain the hog will not have first choice of irrigated land in California.

TABLE 56

ANNUAL PER CAPITA CONSUMPTION OF PORK (EXCLUDING LARD) IN THE UNITED STATES, AND ANNUAL PER CAPITA SLAUGHTER OF PORK IN CALIFORNIA, 1922-1929

In pounds per capita, dressed weight

Year	California slaughter	United States consumption	Year	California slaughter	United States consumption
1922	48.1	66.1	1926	36.0	65.7
1923	51.5	74.7	1927	38.1	68.5
1924	45.4	74.7	1928	44.4	73.9
1925	40.2	67.6	1929	42.9	72.8

Sources of data and bases of estimates:

United States per capita consumption from U. S. Dept. of Agr., Bur. of Agr. Economics, "Statistics of Meat Production, Consumption and Foreign Trade in the United States, 1900-1929." Preliminary Report, April, 1930, Table 6, page 8.

California per capita slaughter based upon Table 52 and estimated California population.

FEED REQUIREMENTS FOR PRODUCING CALIFORNIA POULTRY

Nearly a tenth of all feed produced in California, exclusive of pasture, is fed to poultry. Unlike most of the other California live stock industries, poultry is on an export basis. That is, there is, in excess of California demand, an additional amount available for eastern shipments. In the case of products of the dairy and sheep industries, shipments into the state more than offset shipments to eastern markets. The wide range in the production of eggs per hen in the flocks of California indicates an opportunity for improvement which may very greatly influence the feed requirements for egg production in the future. If egg production per hen is increased to a point now maintained or exceeded by many of the better California flocks and if needs for protein in the human diet are reduced to the degree indicated as possible in Table 40 of Chapter V, the need for land for maintaining the California egg production at the same percentage of United States production as now prevails, would be less in 1970 than now. Trends in the consumption of meats, however, already discussed in Chapter V, would lead to the conclusion that the reduction in the consumption of protein foods shown in Table 40, is probably more drastic than is to be expected. But the possibility of reduced feed requirements per 1000 eggs produced is an important element in making estimates for the future.

Cost of production studies made by the Extension Division of the University of California, together with census data on production of eggs and numbers of chickens, and data on egg shipments supplied by

Professor E. C. Voorhies, of the University of California, have made possible approximate estimates of feed requirements for the poultry industry.

Poultry feed is used to produce eggs and meat for market, to increase the flocks of the industry, which in recent years has been a rapidly growing one, and to replace hens lost through mortality. Those culled for the purpose of flock improvement augment the meat supply. The estimates given in Table 57 include feed requirements for the poultry industry during a period of rapid expansion. Projections into the future should be made with this in mind. If the rate of expansion decreases, less feed will be required per 1000 eggs produced. It is estimated that for the years between 1922 and 1924, from 6 to 7 per cent of the feed used in the poultry industry went into flock increase.

The segregation given in Table 57, based upon feeding practice in the state, is for the purpose of eliminating that part of the feed already accounted for in other live stock industries, and to make a somewhat closer approximation to yields of feed nutrients per acre than could be done by considering the total grain requirement without segregation.* For use in estimating land requirements, the miscellaneous feeds, consisting largely of meat and milk, are subtracted from the total. The basis of these figures is given in more detail in Table 58.

While the cost of production studies forming the background for the items in column 2 are for flocks which are better than the average, the estimates given are the results of determinations of feed requirements for flocks of varying egg-producing power per hen. Estimates were thus made possible for the egg production per hen corresponding to the state average. In the case of the other live stock industries, with the exception of the dairy industry, the feed requirements for the earlier years of the past two decades were estimated on the basis of number of animals. For the poultry industry egg production constituted the means of estimate.

Future Feed Requirements for Poultry Production.

The California population consumes about 20 dozens of eggs per capita per year. Trends in egg consumption in the United States indicate that no reduction can be expected in the near future. The California population of 1970 will, therefore, require between 320 and 400 million dozen, about three times the present production. Shipments from California, however, have increased during the past eight years from 9.8 to 24 million dozen. What they will be in 1970 the best statistics will not reveal; but it seems that 10 per cent of the California production, or 40 million dozen, should be a very conservative estimate, bringing the California production in 1970 up to between 280 and 440 million dozen. On the basis of estimated feed requirements, reduced for a probable increase in output per hen and eliminating miscellaneous feeds derived from by-products accounted for in other estimates, the poultry industry in 1970 should require between 1300 and 1650 million pounds of nutrients to be derived from grain.

* The figures given in the second column would of course vary from year to year. It is believed if a more precise information on the basis of exact rations fed each year could be readily ascertained, more accurate to justify field studies and the labor of such detailed calculations. The feed records used and subsidiary represented by the miscellaneous groups, although included in the total feed requirements for all live stock represented in Table 57, have not been included in the estimates of irrigated land utilized in producing feed for California live stock.

TABLE 57

ESTIMATED FEED REQUIREMENTS FOR CALIFORNIA POULTRY, 1922-1929

In millions of pounds of feed and of digestible nutrients in feed

Kind of feed	Per cent	1922		1923		1924		1925		1926		1927		1928		1929	
		Nutrients	Feed	Nutrients	Feed	Nutrients	Feed	Nutrients	Feed	Nutrients	Feed	Nutrients	Feed	Nutrients	Feed	Nutrients	Feed
Totals	100	567		591		599		638		669		699		737		725	
Yellow corn	25.0	141.8	168.4	147.8	175.5	149.8	177.9	159.5	189.4	167.3	198.7	174.8	207.6	184.3	218.9	181.3	215.3
Wheat or kafir	23.8	134.9	168.4	140.7	175.7	142.6	178.0	151.8	189.5	159.2	198.8	166.3	207.6	175.4	219.0	172.6	215.5
Barley or oats	23.6	133.8	168.5	139.4	175.6	141.4	178.1	150.6	189.7	157.9	198.9	165.0	207.8	173.9	219.0	171.1	215.5
Miscellaneous	27.6	156.5	167.6	163.1	174.6	165.2	176.9	176.1	188.5	184.6	197.6	192.9	206.5	203.4	217.8	200.0	214.1

Sources of data and basis of estimate:

Total nutrients are from Table 54.

The "University of California Poultry Ration" supplied by the Extension Service, University of California, was reduced to a percentage basis. These percentages were multiplied by the total requirements to obtain approximate amount of different kinds of nutrient feed used. In applying these estimates to the determination of land requirements it is clear that the total is the important figure and that a small error in the percentage of one kind of feed or another should be insignificant in conversion of nutrients to acres.

TABLE 58

BASIS OF ESTIMATING FEED REQUIREMENTS FOR CALIFORNIA POULTRY, 1922-1929

Year	1 Average egg production per hen	2 Pounds of mixed grain required per 1,000 dozen eggs	3 Egg production (thousands of dozens)	4 Total pounds required (millions of pounds)
1922	112	5,410	88,479	367
1923	117	5,270	93,663	391
1924	102	6,130	97,927	599
1925	127	5,960	106,340	638
1926	132	5,840	114,418	669
1927	137	5,700	122,879	699
1928	142	5,560	132,960	747
1929	147	5,400	134,383	725

Sources of data:

Column 1. Determined by straight line trend down through average egg production for 1920 and 1925 and extended to 1929.

Column 2. Based on analysis of original data submitted by the Extension Division, University of California, in poultry management studies.

Column 3. Egg production, 1922-1929, was computed as follows. California per capita consumption for 1924 was computed on the basis of estimated 1924 California population and 1924 egg production from U. S. Census of Agriculture 1925, minus shipments out of California. This per capita consumption, together with population figures, form the basis of California consumption 1922-1929, and to this was added out-of-state shipments.

Column 4. Column 2 x column 3 ÷ 12

THE RETIREMENT OF THE HORSE

Substitution of motor horsepower for animal horsepower is one of the outstanding trends of recent years. The retirement of the horse is pointed to as an important cause of overproduction. It has been estimated that more than a quarter of the increase in agricultural production in the United States from 1920 to 1925 was brought about by the release of crop land from the production of horse feed.

The number of horses and mules in California in 1929 was less than 60 per cent of the number in 1909. The ratio of colts to horses has continued downward, indicating a further decline for the immediate future. The decline during the past decade has been at the rate of 155,000 horses and mules per decade. This rate, if continued, would exterminate the horse and mule, so far as California is concerned, in less than 19 years and would add the equivalent of 350,000 acres of irrigated land to the harvested crop acreage of the state. But it would seem unlikely that the horse would completely disappear in two decades and that a slower decline than has taken place during the past decade is likely to characterize the trend of the next 20 years.

During the past two decades a sufficient area of land formerly producing feed for horses has been released to have taken care of 61 per cent of the increase in feed requirements for the dairy industry. Although for the most part the same types of feed are not utilized by horses and beef cattle, it is interesting to note that the feed made available by the reduction in the number of horses would have supplied the entire amount represented by the increase in the demands of the beef cattle industry or would nearly have supplied the additional amounts required by the rapidly increasing number of sheep. *Of the increase during the two decades in feed used by all live stock enterprises, other than horses, the feed released by horses has provided more than 25 per cent.*

In Table 59 the feed requirements for horses from 1922 to 1929 are given. Because of the wide interest in the effect of the reduced number of horses upon the agricultural industry as a whole, particular care was exercised in obtaining figures on the trend in the consumption of horse feed. Account has been taken of changes in the ratio of horses to colts and the resulting change in feed requirements per horse. In using these estimates in constructing Table 61, the larger numbers of colts in the earlier years was again considered. In 1910

TABLE 59

ESTIMATED FEED REQUIREMENTS FOR CALIFORNIA HORSES AND MULES, 1922-1929

In millions of pounds of digestible nutrients

Year	Hay	Grain	Pasture	Total
1922	1,987	91	250	2,328
1923	1,921	87	242	2,250
1924	1,854	84	234	2,172
1925	1,788	81	225	2,094
1926	1,716	78	216	2,010
1927	1,655	75	208	1,938
1928	1,577	72	199	1,848
1929	1,511	69	190	1,770

Sources of data and bases of estimates:

Estimates of feed requirements for horses were obtained from a number of sources, based upon records of rations actually fed. Data from these studies were used in conjunction with tables given by Henry and Morrison (Henry, W. A., and F. B. Morrison, Feeds and Feeding. Appendix. Table 3. 1922) to compute the nutrient content of the feeds in each case. Following are sources with the rations in each reduced to digestible nutrients:

Cooper, M. R., Cost of Keeping Farm Horses and Cost of Horse Labor. U. S. Dept. of Agr. Bul. **560.** July 9, 1917. (A study of records for 316 horses on 27 farms in Illinois, Ohio and New York.) Digestible nutrients required per horse per year, in addition to 97 days pasture per horse per year, 5,804 pounds.

Williams, J. O., and Earl B. Krantz, Care and Management of Farm Work Horses. U. S. Dept. of Agr. Farmers' Bul. **1419.** Issued June, 1914. Revised Nov., 1925. Digestible nutrients required per 1,000-pound horse per year at medium work all year, 6,482 pounds.

Bell, G. A., and J. O. Williams, Feeding Horses. U. S. Dept. of Agr. Farmers' Bul. **1030.** Dec., 1916. Digestible nutrients per 1,000-pound horse per year at light work entire year, 5,475 pounds.

Cooper, M. R., and J. O. Williams, Cost of Using Horses on Corn Belt Farms. U. S. Dept. of Agr. Farmers' Bul. **1298.** 1922. In this study rations are given for maintenance only, light work, medium work, and heavy work. Applied to California conditions—170 days at medium work and 195 days idle—a requirement of 6,025 pounds of digestible nutrients per horse per year is indicated.

Adams, R. L., Cost of Work Horses on California Farms. California Agr. Exp. Sta. Bul. **401.** 1926. Digestible nutrients required per horse per year, 6,326 pounds. The data in this study were taken from the records of 187 California farms on which cost data were collected for 812 work horses. The average time at work per horse per year is 1,527 hours or 170 nine-hour days. On these farms an average of five months of pasture replaced 1.7 tons of hay. The complete average ration per horse per year is as follows: Hay, 5.4 tons, containing 5,400 pounds digestible nutrients; grain, 308 pounds, containing 246 pounds; pasture, two months, containing 680 pounds (five months' pasture=1.7 tons of hay).

On the basis of the above studies, the following ration per horse per year was used in determining feed requirements for California horses and mules: Hay, 10,244 pounds, containing 5,122 pounds digestible nutrients; grain, 291 pounds, containing 233 pounds; pasture, two months, containing 645 pounds. Total, 6,000 pounds digestible nutrients.

This ration was applied to the estimated number of horses and mules in the state to determine feed requirements for horses and mules in California from 1922 to 1929 inclusive. The trend in the ratio of colts to horses has made a difference in feed requirements. A correction has been applied to these estimates, therefore, to correct for changes in this ratio.

colts were 13.5 per cent of the total number of horses and mules. By 1920 this had dropped to 10.5 per cent, and in 1925 to 5.7 per cent. The average number of pounds of nutrients in feed per horse (including mules and colts) has varied from 5421 in 1910 to 5566 in 1929. These estimates of feed requirements applied to the number of horses given in Table 60 were used, together with estimates for other live stock, in constructing Table 61.

SUMMARY OF FEED REQUIREMENTS FOR ALL LIVE STOCK

The detailed studies of feed requirements for each of the live stock industries from 1922 to 1929, inclusive, were used in extending the estimates back to 1909. It has already been stated that this was done on the basis of the number of animals in all cases except for the dairy

and poultry industries. Estimates for these were extended back on the basis of statistics on the volume of the product. A summary for all important groups of live stock is given in Table 61. This table is important not only from the standpoint of the facts revealed as to comparative trends in feed requirements, but it also serves as a means of estimating the trends in the feed supply derived from different kinds of feed.

Attention has been called to the significance of the trend in amounts of feed used by horses. Plate XL, which is based upon Table 61, shows the resultant of the trends in feed used by all the different groups of live stock. The increase in total feed requirements in the 20-year period was 26 per cent. During the same period California population increased 138 per cent. The slight increase in requirements for beef cattle, because of the growth in the practice of fattening of feeders shipped in from other states, and the decline in home produced pork, stand out as important elements, which, with what has already been said about horses, explains the low percentage of increase for the total. *Feed used by dairy cattle, sheep, lambs and poultry, has increased nearly 75 per cent, while that used by the beef cattle industry increased only 28 per cent, and that fed to horses and swine decreased by more than 30 per cent.*

TABLE 60

NUMBERS OF HORSES AND MULES IN CALIFORNIA, 1909-1930

Numbers in thousands

Year	Horses	Mules	Total	Per cent mules
1910	498	74	572	13.5
1911	500	71	571	—
1912	498	73	571	—
1913	500	74	574	—
1914	490	73	563	—
1915	488	73	561	—
1916	488	69	557	—
1917	452	63	515	—
1918	422	63	485	—
1919	402	60	462	13.0
1920	373	60	433	—
1921	360	61	421	—
1922	336	62	397	—
1923	317	59	376	—
1924	314	61	375	16.3
1925	302	58	360	—
1926	293	58	351	—
1927	278	57	335	—
1928	267	51	318	—
1929	249	48	297	—
1930	240	46	286	—

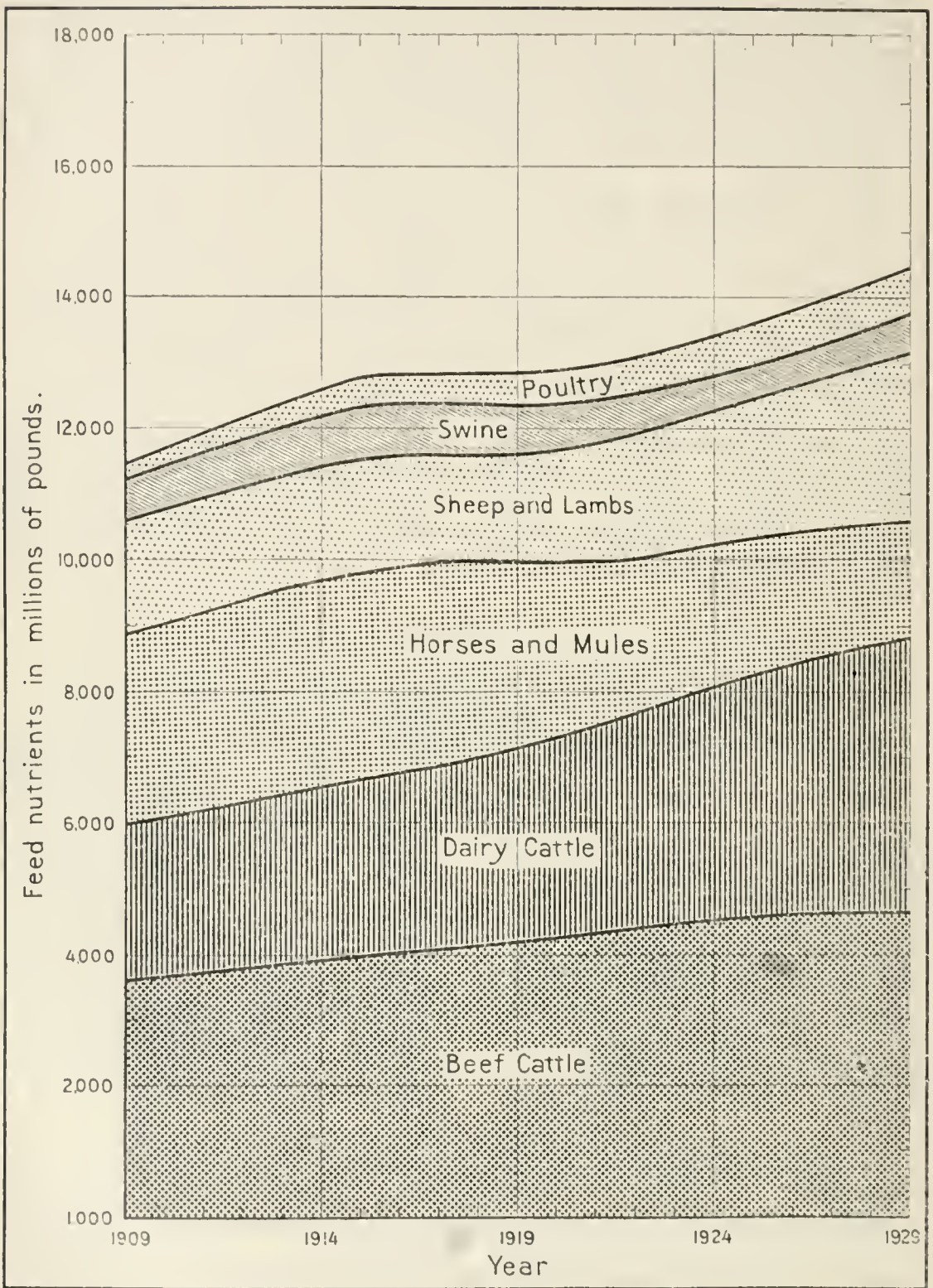
Sources of data:

For 1910 from U. S. Census. 1911-1924 from the Yearbooks of the U. S. Dept. of Agr. 1925-1927 from U. S. Dept. of Agr. Crop and Livestock Estimates. 1928-1930 from U. S. Dept. of Agr. Bur. Agr. Economics, Crop and Livestock Reports.

Relation of Feed Utilization to Requirements for Irrigated Land.

The detailed studies of feed utilization from 1922 to 1929 have made possible an approximate segregation of feeds according to kinds. This segregation is given in Table 62, and is shown graphically in Figure 1 of Plate XLI. It will be noticed that the totals are approximately the same as in Table 61. A number of important observations should be made with respect to this illustration. Crop land supplies about half the feed required by California live stock. The proportion of feed contributed by crop land has increased from a little less than half of

Plate XL



TRENDS IN
FEED NUTRIENT REQUIREMENTS
FOR
CALIFORNIA PRODUCED LIVE STOCK

TABLE 61

TRENDS IN FEED REQUIREMENTS FOR CALIFORNIA LIVE STOCK, 1909-1939

In millions of pounds of digestible nutrients

Year	Dairy cattle	Beef cattle	Horses and mules	Sheep	Swine	Poultry	Total
1909	2,555	3,010	2,205	1,700	652	247	11,441
1914	3,010	3,000	2,150	1,710	705	675	12,560
1919	3,925	4,150	2,305	1,785	740	760	13,837
1922	3,910	4,500	2,225	1,805	760	795	14,001
1924	4,440	4,455	2,280	1,875	805	860	15,245
1924	5,570	4,005	2,175	1,910	825	910	15,195
1925	5,700	4,560	2,075	2,125	860	925	15,485
1926	5,850	4,565	1,985	2,315	895	950	15,785
1927	5,560	4,660	1,910	2,500	925	975	14,000
1928	4,965	4,725	1,845	2,450	950	700	14,285
1929	4,800	4,850	1,770	2,565	980	725	14,455

Basis of estimate:

This table has been constructed from data given in Tables 42 to 60 inclusive, and statistics on numbers of animals and production of butterfat and eggs. The estimates given in this table are trend values obtained by graphically smoothing the results given in the basic tables referred to.

the total in 1909 to a little more than half in 1929. Concentrates are to some extent imported and to some extent by products of crops produced on irrigated land. On the whole they are of secondary importance from the standpoint of irrigation, but are gaining in importance in their proportion to the total. This is more than offset, so far as the use of irrigated land for live stock is concerned, by the gain of alfalfa over the other hay crops. Although the combined acreage in hay decreased 22 per cent from 1909 to 1929, the feed value of hay increased 30 per cent. This is because of the increasing proportion of alfalfa hay in the total.

The resultant effect of these changes in the source of feed upon requirements for irrigated land is shown in Figure 2 of Plate XLI and Table 64. It is estimated that in 1929 the irrigated crop land in California used in producing feed for live stock amounted to 1,287,000 acres, a net increase of 185,000 acres, or 17 per cent, in the decade 1909 to 1929. It must be remembered that as this report is being written the results of the 1930 census of irrigation are not available. We have, however, the trends in the utilization of land for different crops described in Chapter IV, a survey by the State Engineer of irrigated areas in the San Joaquin and Sacramento valleys in 1929, percentages and acreages of the different crops irrigated in 1909 and 1919 and estimates of the total feed requirements segregated by kinds of feed. These have been useful in estimating and checking the results of estimates of the irrigated area in 1929.

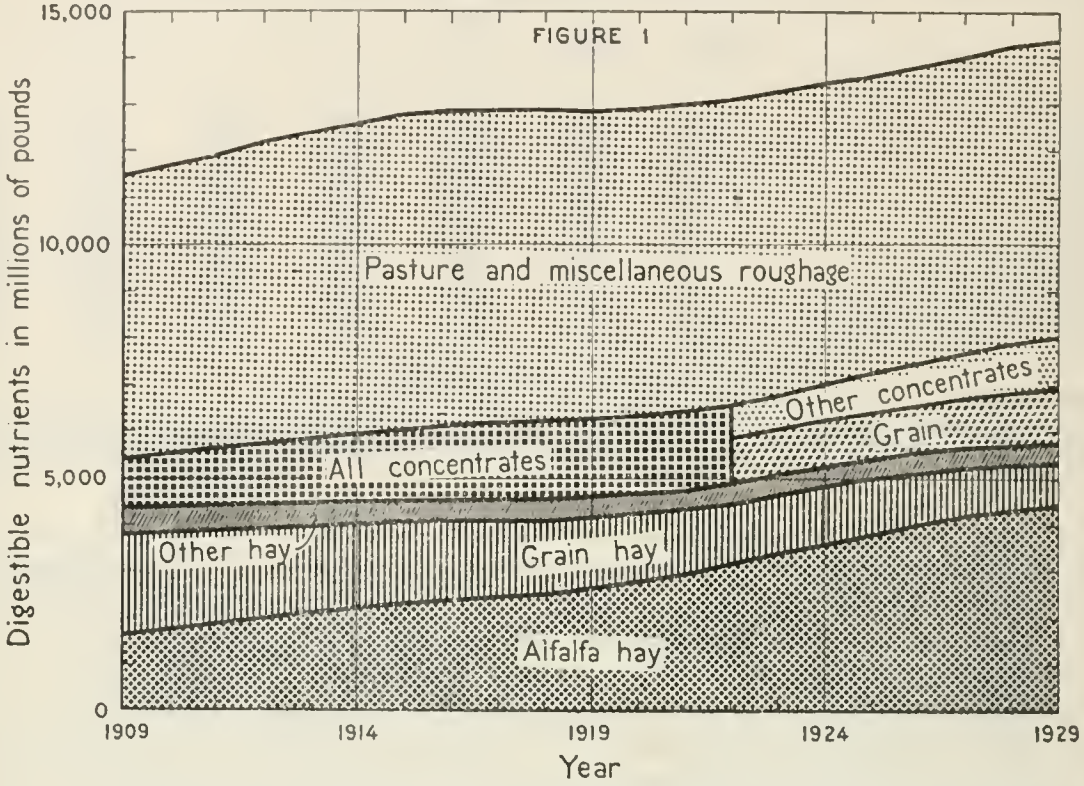
Future Requirements for Irrigated Land for Live Stock.

If the production of fruit should become highly profitable and if land should become very scarce, the future live stock industry of 1970 could subsist on an irrigated acreage of 428,000 acres less than it used in 1929. In other words, we could get along, if forced to, with two-thirds of our present alfalfa acreage. To do this we would have to buy all our butter and cheese from other states, increase the butterfat production per cow from an average of 247 to 275 pounds, reduce the amount of roughage per cow from 30.6 to 20 pounds per day (out of

Plate XLI

TRENDS IN THE TOTAL FEED NUTRIENTS REQUIRED BY CALIFORNIA LIVESTOCK INDUSTRIES CLASSIFIED BY SOURCES

FIGURE 1



TRENDS IN IRRIGATED CROP LAND ACREAGE DEVOTED TO THE PRODUCTION OF CROPS USED IN FEEDING CALIFORNIA LIVESTOCK

FIGURE 2

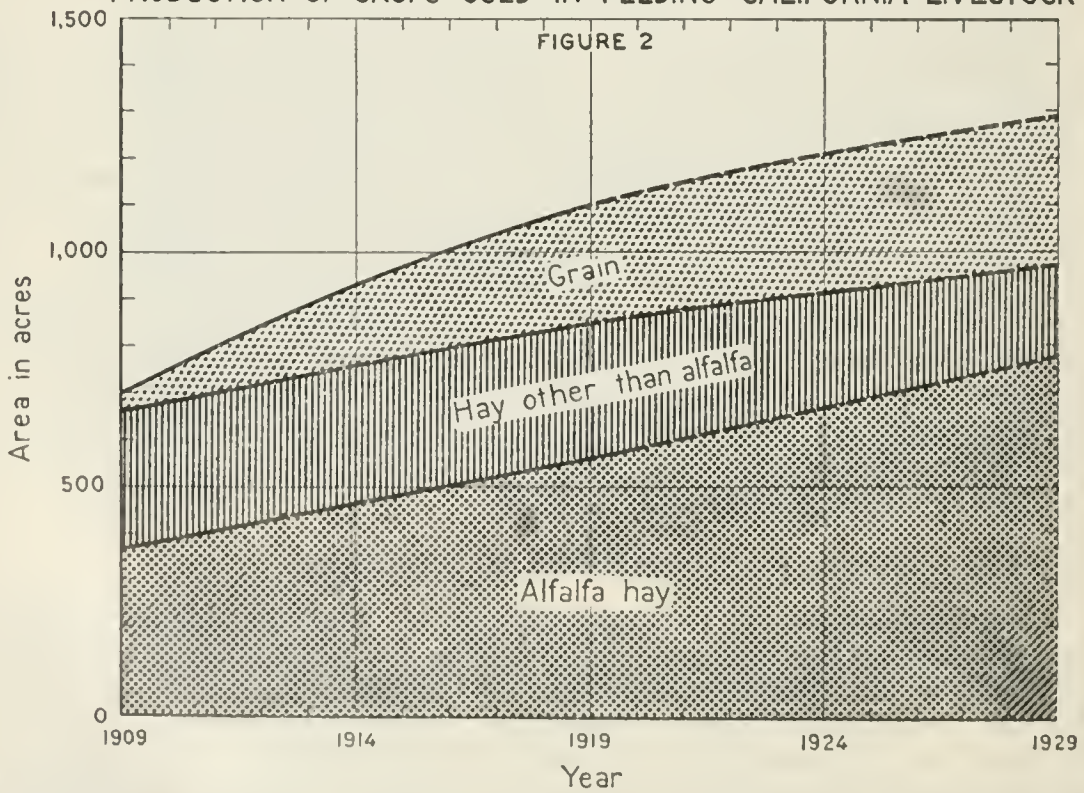


TABLE 62

TREND IN NUTRIENT REQUIREMENTS FOR CALIFORNIA LIVE STOCK, 1909-1929, SHOWING APPROXIMATE PROPORTIONS DERIVED FROM VARIOUS TYPES OF FEED

[In millions of pounds]

Year	Alfalfa hay	Grain hay	Other tame hay	Wild hay	Grain	All concentrates[1]	Pasture and stubble-harvested roughage	Total
1909	1,500	2,100	200	600		1,050	6,000	11,450
1914	2,200	1,800	200	725		1,450	6,025	12,450
1919	2,100	1,525	200	600		1,675	6,500	12,540
1922	3,150	1,250	275	175	975	1,775	6,575	13,200
1923	3,000	1,200	225	225	900	1,675	6,525	13,050
1924	2,940	1,250	200	200	1,050	1,750	6,450	13,440
1925	2,750	1,100	200	200	975	1,850	6,375	13,500
1926	3,050	1,140	250	300	1,000	1,900	6,375	13,775
1927	4,100	1,100	250	300	1,050	2,025	6,375	14,100
1928	4,250	975	250	300	1,125	2,100	6,425	14,325
1929	4,025	925	250	300	1,175	2,315	6,460	14,450

[1] Including grain.

Sources of data and basis of estimate:

The segregation has been made on the assumption that the hay placed out of the state is negligible in quantity compared to the total consumption in the state. Hay production from 1909 to 1929 was converted to its equivalent in pounds of digestible nutrients. From a study made by producers of livestock and farm management investigations it has been possible to determine an approximate trend in the amount of concentrates fed to livestock from 1922 to 1929. The results of these determinations are given in Table G. The concentrates have been separated into two groups—grain and other concentrates. The sum of the nutrients in hay and concentrates has been subtracted from the total feed requirements. It is obvious that this residue represents the feed supplied by pasture lands and a small amount of miscellaneous roughage, stubble, etc. This has given a means of measuring approximately the feed value of our grazing land. These are widely varying character, however, and pasture acreages have not remained constant. Mr. T. I. H., in the preparation of the report, has estimated the acreages in pasture of various kinds from 1879 to 1924. On the basis of the detailed estimate of feed requirements for the period 1922 to 1929, and these trends in pasture acreages weighted by approximate carrying capacities, the trend in feed supplied by pasture was carried back to 1909. It remained only to subtract the sum of nutrients supplied by pasture and by hay from the total requirements to determine for 1909 that part derived from concentrates. The salient points of this evaluation will be made better understood by observing Plate XLI, which is based upon this table.

TABLE 63

DIGESTIBLE NUTRIENTS FROM GRAIN AND OTHER CONCENTRATES FED ANNUALLY TO CALIFORNIA LIVE STOCK, 1922-1929

[In millions of pounds]

	Grain							
	1922	1923	1924	1925	1926	1927	1928	1929
Dairy cattle	167	168	153	206	201	204	206	315
Beef cattle	7	8	10	11	13	14	14	13
Horses and mules	91	82	84	81	78	76	72	69
Sheep	18	18	18	17	18	18	18	18
Swine	369	380	342	314	291	290	310	319
Poultry	410	420	414	442	494	508	594	525
Total grain	662	686	574	691	1,095	1,110	1,214	1,259

OTHER CONCENTRATES

Dairy cattle	270	295	316	340	421	481	550	560
Beef cattle	74	64	105	118	135	146	161	181
Sheep	60	53	78	80	87	87	95	97
Swine	34	83	74	96	89	79	92	96
Poultry	150	167	168	179	185	165	269	250
Total other concentrates	581	711	741	858	917	958	1,079	1,184
Total concentrates	1,243	1,397	1,315	1,549	2,012	2,068	2,293	2,443

TABLE 64

ESTIMATED TREND IN IRRIGATED ACREAGE UTILIZED IN PRODUCING FEED FOR CALIFORNIA LIVE STOCK, 1909-1929

In thousands of acres

Year	Alfalfa hay	Other hay	Grain	Total
1909	367	292	43	702
1914	462	292	148	902
1919	557	293	252	1,102
1929	775	196	316	1,287

Sources of data and basis of estimate:

This table has been constructed on the basis of the trends in the utilization of land for different crops described in Chapter IV, a survey by the State Engineer of irrigated areas in the San Joaquin and Sacramento valleys in 1929, percentages and acreages of the different crops irrigated in 1909 and 1919 (14th Census of the U. S., State Compendium Calif., Table 18, pp. 106-7), and estimates of the total feed requirements segregated by kinds of feed given in Table 62

which the roughage for the other animals in the herd would have to be fed) and if irrigated land was not available for the production of concentrates then grain, cottonseed or other concentrates would have to be shipped in from other countries or states, or grain from our dry-farmed areas used. The entire feed now consumed by horses would have to be utilized for other live stock, and the feed provided by pasture and miscellaneous forage increased more than 60 per cent. This increase is anticipated by those familiar with range conditions. Part of this increase would come from the eradication of poisonous weeds, construction of stock watering facilities and protection of the range from overstocking. Much of the expected increase would come from more complete utilization of waste feeds and pastures within farms.

Whether needed supplies of butter and cheese are provided by shipments from sources outside the state or by the development of additional acreage in California, costs will be higher unless there is further marked increase in the efficiency of producing dairy products. The reduction in the amount of feed required per pound of butterfat produced has not been accompanied, in California at least, by material reductions in the cost per pound of butterfat. If costs were to continue the same, present California producers would not have the prices of their products reduced by an increase in the amount of butterfat marketed if present per capita consumption of butterfat in California were not exceeded, and if conditions of demand for the products of the dairy industry remain the same as the average of recent years. There is no assurance that costs of production and the per capita demand for dairy products will remain the same as they have been in the recent past. There is, however, no definite means of estimating what the changes will be. Of the two alternatives presented, that of producing only the non-importable products, or that of producing the same per capita amount of butterfat as at present, the latter seems the most probable.

If we should continue our present per capita production, import the same proportion of butter and cheese as in 1929, feed the same amount of roughage per cow as in 1929, keep one-fourth of the horses now in the state (a purely arbitrary figure), but increase the production per cow to 275 pounds, we should need, in addition to the feed now produced, the amount to be released by horses and that which would be

added by increased pasture productivity, or the equivalent of 1,450,000 acres of alfalfa, for roughage alone.

In the case of the concentrates, the calculation of requirements for irrigated land is not so simple. About half of our concentrates now come from cottonseed and imported products. The other half comes from grain, about 22 per cent of which is produced on irrigated land. As irrigated land becomes scarce the percentage of irrigated grain to the total should decline. Past trends support this conclusion. If the percentage of irrigated grain by weight of product should remain at about one-fifth of the total production we should use the yield from nearly 600,000 acres of irrigated land in 1970. It is doubtful if irrigated land will be used for grain production to that extent in 1970. The irrigated cereal acreage in 1919, exclusive of rice, was 456,975 acres, or about 18 per cent of the acreage of the same crops for the state as a whole.

In view of the fact that non-irrigated grain and other concentrates are so easily substituted, it is doubted if extreme accuracy in this particular item is important. The grains used for feeding live stock, weighted according to their importance for that purpose, yield about 877 pounds of digestible nutrients per acre. This is for irrigated and non-irrigated land. Yields of grain on the irrigated lands average about 20 per cent greater than on non-irrigated land when weighted according to their importance for live stock feed. Irrigated grain can be expected to produce about 1000 pounds of digestible nutrients, while alfalfa yields 4310.

It is estimated that under the condition stated, we should be able to add 362,500 acres of irrigated alfalfa or its equivalent to our agricultural land during each of the next four decades without upsetting the prices of live stock products. This figure should not be considered as final, however, until we have considered the requirements for fruits and vegetables. The requirement for live stock can be cut down if necessary by reducing the amount of roughage per cow by 30 per cent, or by importing a greater percentage of butter and cheese.

CHAPTER VII

LAND REQUIREMENTS FOR THE PRODUCTION OF FRUITS, VEGETABLES AND MISCELLANEOUS FIELD CROPS

The growth of the fruit industry in California is dependent to a large extent upon the growth of United States population, upon the per capita consumption of fruit by that population, and upon the extent to which foreign markets for California fruit can be expanded. A consideration of the long time outlook for the California fruit industry as a whole involves a somewhat different procedure than would be followed for any particular kind of fruit. The demand for one kind of fruit is influenced by changing tastes for others. Over expansion in one fruit industry may curtail the acreage planted to another. One fruit crop may be in a bad state economically, while another one thrives. Each of the different fruits has certain inherent economic characteristics, and each has problems to be worked out by those engaged in its production. While these problems are related to the general problem of land requirements for the fruit industry as a whole, it is not necessary to go into the details of analysis of the economic situation of each individual fruit industry for the determination of land requirements for all fruits. Some consideration should be given, however, to the extent to which individual fruits may affect or be affected by the expansion of the total acreage of fruits.

It was pointed out in Chapter V that, although there has been considerable evidence of increased per capita consumption of fruit in recent years, the trend in per capita consumption has probably not been rising so rapidly as is indicated by the tendency in recent years. Furthermore, the trend in per capita production has in it the element of foreign trade and may remain horizontal, even though there may be actually an upward trend in per capita consumption.

The method used in estimating future land requirements for the fruit industry, as finally decided upon, after careful consideration of available data, has involved the assumption of a future constant per capita production of fruit in the United States. This assumption is justified by statistics of fruit production. Future United States production has been estimated by multiplying estimates of future United States population as predicted by the Scripps Foundation by the United States normal per capita production. This population prediction is described in Chapter II.

The trend in California production of fruit in per cent of United States production, projected into the future and multiplied by the estimates of United States production, constitutes the final step in estimating future California production. This estimate, in turn, is used as an index of acreage requirements for the fruit industry. The irrigated land requirements for the California fruit industry are estimated on the basis of the trends in the area of irrigated and non-irrigated fruit lands described in Chapter IV.

A joint analysis of fruit production in California and in the United States made with Dr. S. W. Shear, of the California Agricultural

Experiment Station, has revealed important facts which are pertinent to the analysis of California's need for irrigated land. A 20-year series of data on the production of individual fruits converted to a fresh fruit basis and compiled by Dr. Shear * constitutes the basis of this study.

California Fruit Production.

The production of California temperate zone tree fruits has increased from about 1400 million pounds in 1909 to more than 3800 million pounds in 1928. While temperate zone fruits were making this increase in volume of production, sub-tropical fruits increased in volume nearly three times. The volume of production of all orchard and vineyard fruits reflects this rapid growth increasing from about 4000 million pounds in 1909 to nearly 12,000 million pounds in 1928. In 1929 fruit production throughout the state fell off considerably. While the fruits were thus expanded in volume of production, almonds and walnuts combined increased in production from an output somewhat in excess of 20 million pounds in 1909 to more than 120 million pounds in 1928. Inasmuch as pounds of fresh fruit are not exactly comparable with an equal weight of nuts, it has been thought best to carry out future estimates on the basis of the fruits alone, bringing the percentage of nuts into the picture by using the future trend of fruit production as an index of fruit and nut acreage. These trends are shown graphically in Figures 1, 2 and 3 of Plate XLII. The data from which these illustrations have been constructed are given in Table 65.

United States Fruit Production.

In Table 66 are recorded the summarized United States production figures for grapes, citrus and temperate zone fruits. During the period 1909 to 1929, in which California temperate zone tree fruit production was more than doubled in volume, United States production of the same fruits remained fairly constant. It is true that there have been wide variations from year to year and there was evidently a cyclical variation. In 1914 and 1926 United States production of temperate zone fruits reached maximum heights. In 1926 the production reached a higher point than in 1914, but the average production of temperate zone fruits for the three years, 1913, 1914 and 1915, was slightly greater than the average production for 1925, 1926 and 1927. The average production for the years 1918, 1919 and 1920 was more than 2000 million pounds less than the averages for the other two periods mentioned above. Although the production of temperate zone fruits did not increase appreciably during the past two decades, that of grapes and citrus more than doubled. This is to a large extent a reflection of what took place in California with respect to these fruit crops. Cyclical variations in United States production of temperate zone and sub-tropical fruits are brought out in the three illustrations of Plate XLIII.

* Dr. Shear's study, Fruit Production, Consumption and Utilization in the United States, now in preparation, will be published as a bulletin of the California Agricultural Experiment Station.

TABLE 65

CALIFORNIA PRODUCTION OF SUB-TROPICAL AND TEMPERATE ZONE FRUITS

In millions of pounds

Year	Sub-tropical fruits					Temperate zone fruits	Temperate zone and sub-tropical fruits combined
	Grapes	Citrus	Figs	Grapes and citrus	Grapes, citrus and figs		
1909	1,716	981	24	2,697	2,721	1,409	4,130
1910	1,676	1,373	23	3,049	3,072	1,265	4,337
1911	1,641	1,212	33	2,853	2,886	1,400	4,286
1912	1,872	552	30	2,424	2,454	1,775	4,229
1913	1,759	1,455	30	3,214	3,244	1,198	4,442
1914	2,118	1,415	39	3,533	3,572	1,745	5,317
1915	2,306	1,384	52	3,690	3,742	1,717	5,459
1916	2,022	1,773	59	3,795	3,854	1,685	5,539
1917	2,444	796	52	3,240	3,292	2,153	5,445
1918	2,183	1,712	55	3,895	3,950	1,655	5,605
1919	2,660	1,425	72	4,085	4,157	2,548	6,705
1920	2,546	1,993	74	4,539	4,613	2,008	6,621
1921	2,200	1,236	58	3,436	3,494	1,894	5,388
1922	3,612	1,694	71	5,306	5,377	2,537	7,914
1923	4,060	2,216	63	6,276	6,339	2,640	8,979
1924	3,070	1,675	55	4,745	4,800	2,411	7,211
1925	4,100	2,279	64	6,379	6,443	2,577	9,020
1926	4,258	2,589	78	6,847	6,925	3,246	10,171
1927	4,812	2,103	83	6,915	6,998	3,361	10,359
1928	4,732	3,360	81	8,092	8,173	3,804	11,977
1929	3,502	2,173	102	5,675	5,777	2,384	8,161

Sources of data:

This table is the result of a joint analysis made with Dr. S. W. Shear, Division of Agricultural Economics, University of California, of data compiled by the latter. A similar, but more detailed analysis, together with data on individual fruits included, sources of data and methods of compilation, will appear in Shear, S. W., Fruit Production Consumption and Utilization in the United States, California Agr. Exp. Sta. Bulletin (in preparation).

All data are compiled on the basis of fresh-fruit equivalent. Temperate zone fruits include cherries, pears, apricots, apples, peaches, fresh plums and prunes. The vinifera grape, which includes most of California's varieties, citrus fruits, and figs comprise all but a very small percentage of California's sub-tropical fruit acreage. Olives, pomegranates, avocados, dates and a few other sub-tropical crops utilize a very small percentage of the sub-tropical acreage.

TABLE 66

UNITED STATES PRODUCTION OF GRAPES, CITRUS FRUITS, AND OF TEMPERATE ZONE FRUIT

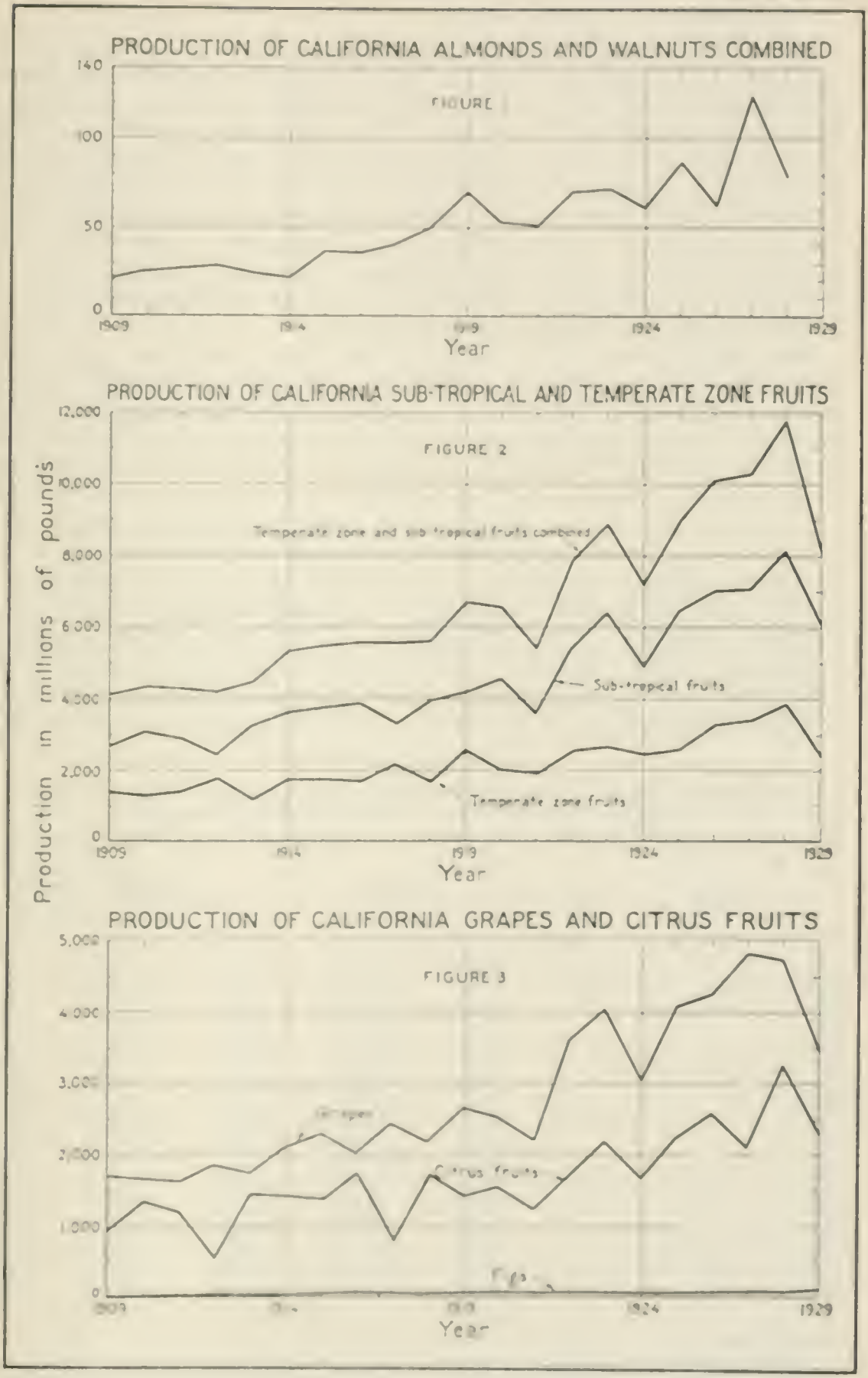
In millions of pounds

Year	Grapes	Citrus	Temperate zone fruits	Grapes and citrus	Temperate zone and sub-tropical
1909	2,307	1,538	9,880	3,845	13,725
1910	2,073	1,871	10,190	3,944	14,134
1911	2,219	1,739	13,114	3,958	17,072
1912	2,423	1,315	15,109	3,738	18,847
1913	2,145	2,311	10,102	4,456	14,558
1914	2,650	2,411	15,932	5,061	20,993
1915	2,704	2,310	15,430	5,014	20,444
1916	2,379	2,815	12,325	5,194	17,519
1917	2,855	1,542	11,901	4,397	16,298
1918	2,476	2,705	11,027	5,181	16,208
1919	3,121	2,540	11,323	5,661	16,984
1920	3,046	2,730	14,888	5,776	20,664
1921	2,424	2,422	7,722	4,846	12,568
1922	4,162	3,186	14,620	7,348	21,968
1923	4,455	4,098	13,940	8,553	22,493
1924	3,555	3,364	12,890	6,919	19,809
1925	4,404	3,657	12,598	8,061	20,659
1926	4,877	4,167	17,774	9,044	26,818
1927	5,210	3,448	10,736	8,658	19,394
1928	5,342	5,501	14,953	10,843	25,796
1929	4,045	3,686	11,162	7,731	18,893

Sources of data:

This table is the result of a joint analysis made with Dr. S. W. Shear, Division of Agricultural Economics, University of California, of data compiled by the latter. A similar, but more detailed analysis, together with data on individual fruits included, sources of data and methods of compilation, will appear in Shear, S. W., Fruit Production, Consumption and Utilization in the United States, California Agr. Exp. Sta. Bulletin (in preparation).

Plate XLII


PRODUCTION OF CALIFORNIA ALMONDS AND WALNUTS COMBINED
FIGURE
140
100
50
0
1909
1914
1919
1924
1929
Year
PRODUCTION OF CALIFORNIA SUB-TROPICAL AND TEMPERATE ZONE FRUITS
FIGURE 2
Production in millions of pounds
12,000
10,000
8,000
6,000
4,000
2,000
0
Temperate zone and sub-tropical fruits combined
Sub-tropical fruits
Temperate zone fruits
1909
1914
1919
1924
1929
Year
PRODUCTION OF CALIFORNIA GRAPES AND CITRUS FRUITS
FIGURE 3
5,000
4,000
3,000
2,000
1,000
0
Citrus fruits
1924
1929
Year

Ratio of California Production to United States Production of Orchard and Vineyard Fruits.

Figure 1 of Plate XLIV and Table 67 show the California production of important orchard and vineyard fruits in per cent of United States production of the same fruits. The average percentage for grapes increased from about 75 in 1909 to more than 92 in 1927, and then dropped to 87; for grapes and citrus combined from about 70 in 1909 to 80 in 1927, dropped to 73 in 1929. The ratio of California citrus fruit production to the United States production of citrus fruits has declined slightly. The percentage for temperate zone fruits has increased from about 14 to approximately 31 in 1927, dropped to 21 in 1929, while for all orchard and vineyard fruits combined the trend of this percentage has increased from 30 to 43.

The projection of this trend into the future constitutes one of the most difficult steps in the procedure of estimating future land requirements. Figure 1 of Plate XLIV shows two possible projections. The line forming the upper margin of the shaded portion of the illustration is the estimated California production, in per cent of that of the United States, which would be required if California should provide all of the increase in the United States during the next 40 years. The horizontal line forming the lower margin of the shaded area is the average California production, in per cent of that of the United States, for the past five years. These are not presented as upper and lower limits of probable future production. There could occur an actual reduction in the acreage of fruit in the United States outside of California, which would make it possible for California to exceed the estimate indicated by the upper line. On the other hand, there might

TABLE 67

PERCENTAGE RELATIONSHIP BETWEEN CALIFORNIA AND UNITED STATES PRODUCTION OF ORCHARD AND VINEYARD FRUITS, 1909-1929

Year	Grapes	Grapes and citrus	Citrus	Temperate zone fruits	Temperate zone and sub tropical fruits
1909	74 38	70 14	63 78	14 26	30 09
1910	80 85	77.31	73.38	12.41	30.68
1911	73.95	72 08	69.70	10 68	25 11
1912	77.26	64 85	41 98	11.75	22 44
1913	82 00	72 13	62.96	11 86	30 51
1914	79 92	69 81	58 69	10 95	25.33
1915	85 28	73 59	59 91	11 13	26 70
1916	84.99	73 07	62.98	13 67	31 61
1917	85 60	73 69	51.62	18 09	33.41
1918	88 17	75.18	63.29	15 01	34 58
1919	85 23	72.16	56 10	22 50	39 48
1920	83 59	78 58	73.00	13 49	32.04
1921	90.76	70 90	51 03	24 53	42.87
1922	86.79	72 21	53 17	17 35	36.03
1923	91 13	73 38	54 08	18 94	39 92
1924	86 36	68 58	49 79	18.70	36 40
1925	93 10	79 13	62 32	20 46	43.66
1926	87 31	75.71	62 13	18 26	37.93
1927	92.36	79 87	60 99	31.31	53.41
1928	88 58	74 63	61 08	25 44	46 43
1929	86 58	73.41	58 95	21 36	43 20

Sources of data:

This table is the result of a joint analysis made with Dr. S. W. Shear, Division of Agricultural Economics, University of California, of data compiled by the latter. A similar, but more detailed analysis, together with data on individual fruits included, sources of data and methods of compilation, will appear in Shear, S. W., Fruit Production, Consumption and Utilization in the United States, California Agr. Exp. Sta. Bulletin (in preparation)

occur a decline in the ratio of California production to that of the United States to a point below the average indicated by the lower line.

Those who have investigated the economic situation of the fruit industries believe that the latter is much more likely to take place. They point out the possibility of shifts in the relative demand for different kinds of fruit which might result in a decline in the production and consumption of some fruit largely grown in California. No such shift is at present indicated by available statistics, however. A reduction in exports resulting from increased competition from supplies produced in foreign countries might greatly affect the production of prunes and raisins. This foreign competition may become more acute as prices rise to more favorable levels. In response to these convincing arguments the lower line has been taken as the basis of future estimates. It should be remembered, however, that the shaded portion of the illustration represents production sought by competing areas. How far California advances into the production of this portion of the United States output will depend upon a continuation of her comparative advantage, low production costs and superior marketing institutions.

United States Per Capita Production of Important Orchard and Vineyard Fruits.

Average per capita production of the important orchard and vineyard fruits in the United States during the past 20 years has been about 177 pounds per annum. During the first of these two decades the average was 173, but the average for the past 10 years has been 182. The cyclical variation observed with respect to total production is reflected in per capita production. The cycle which has just recently passed its maximum is probably not complete. The average for the past decade, therefore, is probably not comparable with that of the previous decade. Figure 2 of Plate XLIV and Table 68 show these variations in per capita production of fruits in the United States. Per capita production of temperate zone fruits has been downward, but there has been an increase with respect to grapes and citrus fruits, which comprise the major part of the volume of the sub-tropical group. Although there may be some increase indicated in the trend of the per capita production of fruit, the average of 182 pounds for the past ten years seems to be sufficiently high for use in estimating future production when the fact is taken into consideration that the ten year period has been one in which the volume of production has been abnormally large. This average multiplied by United States population gives a trend in normal production which can be projected into the future on the basis of United States population.

It will be observed that this average of 182 pounds is eight pounds less than the average for the three years, 1925, 1926 and 1927. In other words, there has occurred recently a period of years during which the production in the United States was above normal. In 1926 more fruit was produced in the United States than ever before or since. The year 1929 was the third year of the decline which seems to have set in.

If history of per capita production repeats itself, we may recluse per capita production to less than 160 pounds before we begin another trend of expansion. A per capita production of 155 pounds was reached in 1919 but that was a year of low yield per acre and the

Plate XLIII

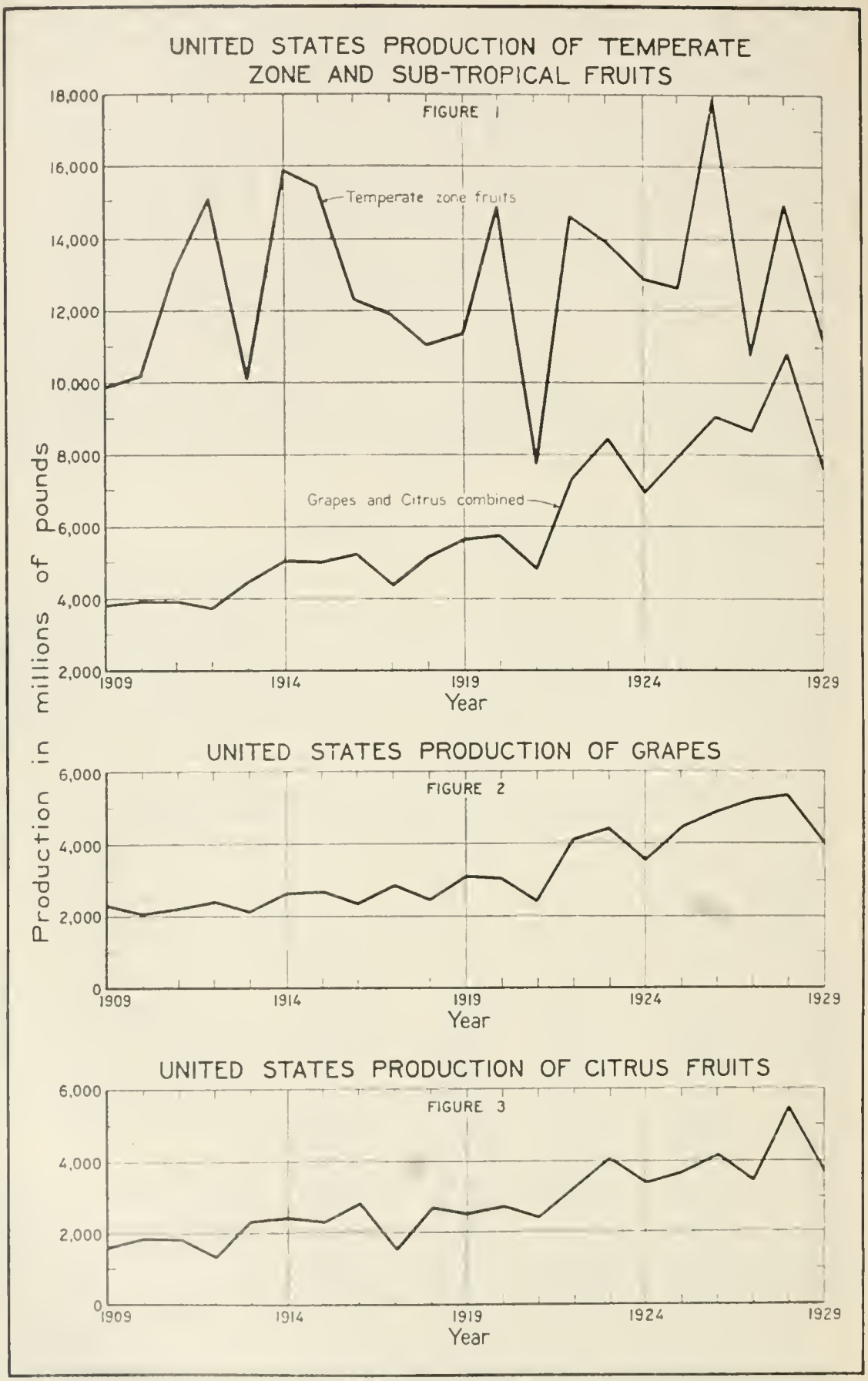
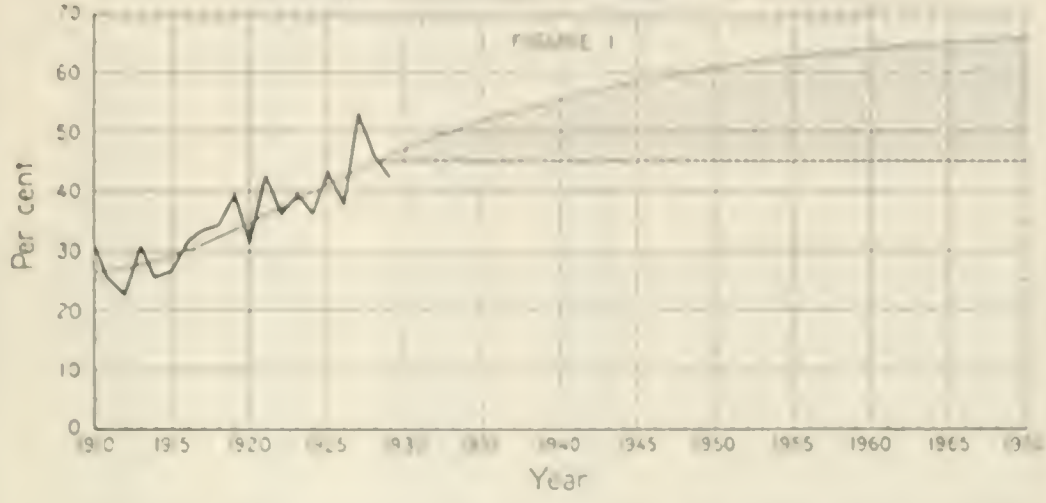

UNITED STATES PRODUCTION OF TEMPERATE ZONE AND SUB-TROPICAL FRUITS
FIGURE 1
Temperate zone fruits
Grapes and Citrus combined
Production in millions of pounds
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
1909
1914
1919
1924
1929
Year
UNITED STATES PRODUCTION OF GRAPES
FIGURE 2
6,000
4,000
2,000
0
1909
1914
1919
1924
1929
Year
UNITED STATES PRODUCTION OF CITRUS FRUITS
FIGURE 3
6,000
4,000
2,000
0
1909
1914
1919
1924
1929
Year

Plate XLIV

PERCENTAGE RELATION BETWEEN CALIFORNIA AND UNITED STATES PRODUCTION OF ORCHARD AND VINEYARD FRUITS, SHOWING POSSIBLE FUTURE PROJECTION



UNITED STATES PER CAPITA PRODUCTION OF IMPORTANT GROUPS OF ORCHARD AND VINEYARD FRUITS 1909 - 1929

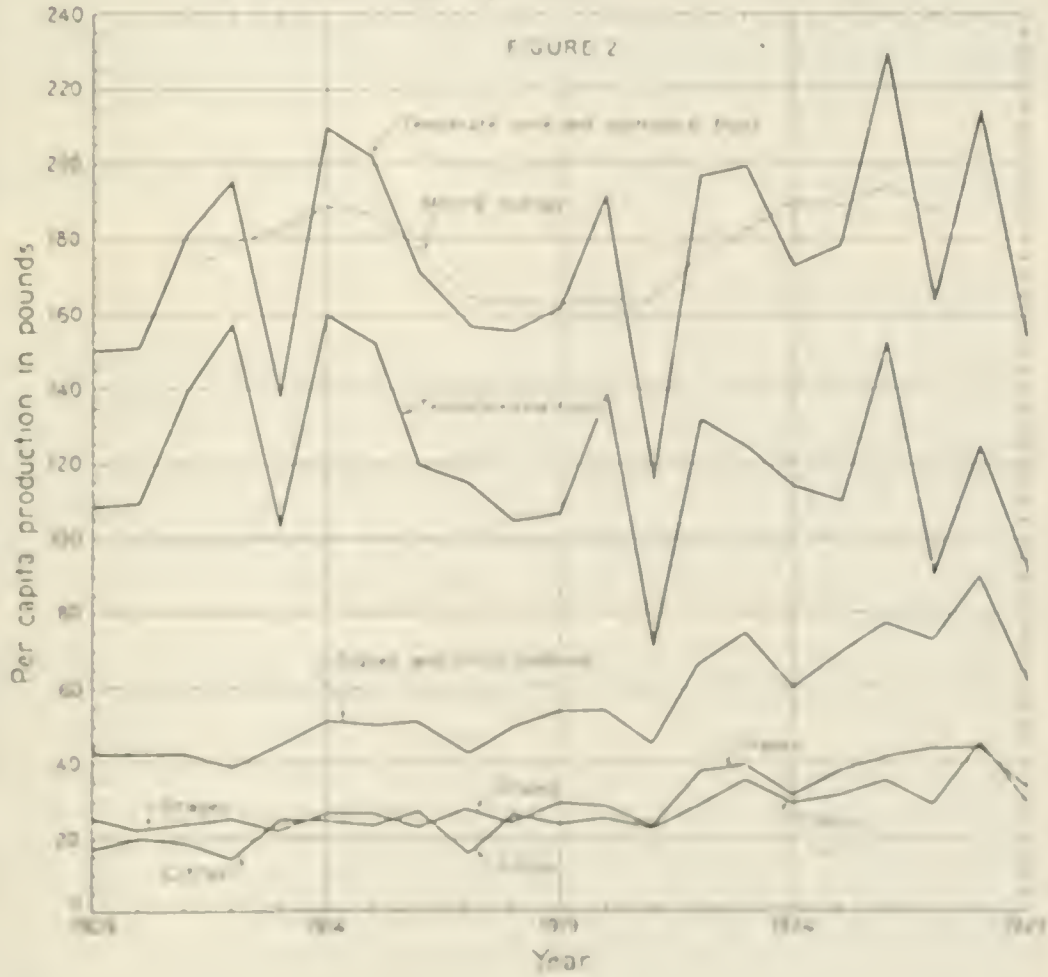


TABLE 68

UNITED STATES PER CAPITA PRODUCTION OF IMPORTANT GROUPS OF ORCHARD AND VINEYARD FRUITS, 1909-1929

Year	Temperate zone fruits, grapes and citrus	Temperate zone fruits	Grapes and citrus combined	Grapes	Citrus
1909	150.0	107.9	42.0	25.2	16.8
1910	151.7	109.4	42.3	22.3	20.1
1911	180.7	138.8	41.9	23.5	18.4
1912	196.0	157.1	38.9	25.2	13.7
1913	148.2	102.9	45.4	21.8	23.5
1914	210.5	159.8	50.8	26.6	24.2
1915	202.3	152.7	49.6	26.8	22 9
1916	170.8	120.1	50.6	23.2	27.4
1917	156.9	114.6	42.3	27.5	14.8
1918	155.1	105.5	49.6	23.7	25.9
1919	160.7	107.1	53.6	29.5	24 0
1920	192.4	138.6	53.8	28.4	25.4
1921	115.2	70.8	44.4	22.2	22.2
1922	198.5	132.1	66.4	37.6	28.8
1923	199.6	123.7	75.9	39.5	36.4
1924	173.3	112.8	60.5	31.1	29.4
1925	178.4	108.8	69.6	38.0	31.6
1926	228.6	151.5	77.1	41.6	35 5
1927	163.2	90.4	72.9	43.9	29.0
1928	214.4	124.3	90.1	44.4	45.7
1929	155.1	91.6	63.5	33.2	30.3

Sources of data:

This table is the result of a joint analysis made with Dr. S. W. Shear, Division of Agricultural Economies, University of California, of data compiled by the latter. A similar, but more detailed analysis, together with data on individual fruits included, sources of data, and methods of compilation, will appear in Shear, S. W., Fruit Production, Consumption and Utilization in the United States, California Agr. Exp. Sta. Bulletin (in preparation).

small figure did not indicate so great a curtailment in average fruit-producing power of the orchards of the country.

Future Requirements for Irrigated Land in California for Orchard and Vineyard Fruits.

On the basis of United States per capita production and the ratio of California production to United States production, it has been estimated that the normal demand for orchard and vineyard fruits in California will increase during the next three decades at the rate of approximately a billion pounds per decade. Estimates of demand for acreage, however, must take into consideration present over-expansion. Table 69 shows the trend in the estimated acreage required for the California fruit industry.

Between 1910 and 1920 the California bearing acreage of orchard and vineyard fruits and nuts increased 230,000 acres. During the same decade the increase in the irrigated acreage of the same fruits increased 218,000 acres, indicating that two decades ago the principal means of expanding the fruit acreage was by irrigation. It is true that many orchards have been irrigated that were not then irrigated. In 1909, 36.7 per cent of the orchard and vineyard fruits and nuts was irrigated, while in 1919, 51 per cent was irrigated.

Acreage expansion in the fruit industry either means more irrigated land, or else less irrigated land used for other crops. It is estimated that the unirrigated acreage of orchards and vineyards is approximately 480,000 acres, and that this will remain fairly constant. There is some possibility of its declining. If it had remained constant during the last

TABLE 69

ESTIMATED FUTURE TRENDS IN THE DEMAND FOR BEARING ACREAGE OF ORCHARD AND VINEYARD FRUITS AND NUTS IN CALIFORNIA

Year	Trend in demand for fruit in millions of pounds	Trend in demand for fruit and nut area in thousands of acres	Year	Trend in demand for fruit in millions of pounds	Trend in demand for fruit and nut area in thousands of acres
1940	11,422	1,730	1960	13,232	2,110
1950	12,418	1,873	1970	14,048	2,210

Sources of data and basis of estimate.

Future United States production was estimated by multiplying United States per capita production 20-year average by future populations of United States as predicted by the Scripps Foundation (see Chapter II). Vertical fluctuation was introduced by the estimated future ratio of California production to United States production to obtain future California production. California production was plotted on semi-logarithmic paper and acreage trends of subtropical and temperate zone fruits and nuts combined from Table 14 were plotted on the same sheet and projected into the future, parallel to the trend of production.

decade the percentage of irrigated fruit land would have been 72 per cent of the total fruit land area in 1929.

Looking into the future, and recognizing the many circumstances that may upset these estimates, by 1970 we will need approximately 2,200,000 acres for fruit and nuts. This will mean that by 1940 we will be able to absorb an additional 80,000 acres. During the decade from 1940 to 1950 we may be able to add another 185,000 acres. Corresponding estimates for the two following decades are 135,000 and 100,000 acres, respectively. These must be recognized as having declining precision as the period to which they apply becomes more remote.

LAND REQUIREMENTS FOR VEGETABLES

Estimates of future land requirements in California for vegetables have been based upon trends in per capita consumption, estimated future population of the United States and trends in the ratio of California acreage to United States acreage of important vegetable crops. Inquiry also has been made concerning the comparative advantage for production which California enjoys and some recognition has been given to the growing home market. Commercial vegetable growing on a large scale, long distance shipping of vegetables and consequent specialization by geographical divisions of the country in the production of vegetable crops have introduced new aspects into the problem of long period predictions. Shifts such as these cause one to realize the revolutionary changes possible with respect to any part of our agricultural industry.

Per Capita Acreage of Vegetables.

If per capita acreage of vegetables in the United States should continue to increase as it has during the past 20 years, it would be about 12 per cent greater in 1970 than at the present time. As near as it is possible to estimate, this is the trend we can expect in the future. It is consistent with expected changes in the human diet and past consumption. In 1909 the United States per capita acreage of vegetables, including white potatoes, as determined from acreage reports in the census, was 0.0562 * In 1919 it had become 0.0565, and in 1924, 0.0569.

* The United States acreages for 1909, 1919, and 1924 were 4,691,000, 5,448,000, and 6,473,000 respectively

It must be emphasized that the small vegetable garden has made these figures rather uncertain. The commercial truck-garden area has been growing so rapidly that for this and other reasons statistics on the growth of acreage utilized for vegetables are not as reliable as for other crops.

It is estimated that the per capita acreage of vegetables in the United States will be 0.059 in 1940, 0.061 in 1950, 0.063 in 1960, and 0.065 in 1970.

Ratio of California Acreage to That of the United States.

Just as the California production was compared to United States production in the case of fruits, the trend in the ratio of California vegetable acreage to that of the United States was determined and projected into the future. Table 70 has been prepared to show the trend in the ratio of California acreage to that of the United States. The acreages given in Table 70 do not contain all of the vegetable crops. Although the major part of the vegetable crops is represented, only those have been included which have made possible the comparison of California acreage with that of the United States. The ratio of California vegetable acreage to that of the United States is now a little more than 0.06. It is estimated that this ratio will increase to 0.08 in 1970. This is probably a hazardous prediction because, unlike California fruits which are already about 47 per cent of United States production, California vegetable production could become a much greater percentage than the estimated 0.08. It is believed that estimate is sufficiently low.

TABLE 70

RATIO OF CALIFORNIA VEGETABLE ACREAGE TO UNITED STATES VEGETABLE ACREAGE, 1919-1928

Year	1 United States acreage	2 California acreage	3 Ratio of column 2 to column 1
1919	5,338,660	234,020	.044
1920	5,567,090	251,010	.045
1921	5,762,480	200,430	.035
1922	6,429,570	239,790	.037
1923	5,831,220	229,160	.039
1924	5,700,000	239,370	.042
1925	5,137,031	263,440	.051
1926	5,185,110	305,550	.059
1927	5,647,040	360,710	.064
1928	5,960,480	362,800	.061

Sources of data:

In order to get United States acreages that were comparable to those of California, the acreages of nine important vegetables were used. These include asparagus, cantaloupes, cauliflower, celery, lettuce, onions, peas, potatoes, sweet potatoes, tomatoes and watermelons. Acreages for the United States are from U. S. Dept. of Agr. Yearbook of Agriculture, 1923, page 759; Yearbook 1925, page 913; Yearbook 1928, pages 789-807. Acreages for California are from California Crop Reports for 1923, 1926 and 1928.

Estimates of future California acreage determined by multiplying this ratio by estimated future United States acreage gave results that would necessitate a decline in California per capita vegetable acreage. This is probably because white potatoes, which are included, are declin-

ing in acreage in California. California will probably continue to produce most of her own vegetables and to ship a considerable amount to other states. The present California per capita acreage is somewhat greater than the corresponding figure for the United States. The per capita production, exclusive of potatoes, probably will remain higher because of an expected increase in per capita consumption of vegetables, California's recognized seasonal advantage in the production of vegetables at a time when most desired by eastern markets, the unlimited opportunity for the expansion of vegetables even at the expense of other crops and the larger percentage of the days in the year when fresh vegetables may be obtained by the California population.

Future Requirements.

Using the estimate of future United States population given in Chapter II and the per capita acreage of vegetables as estimated for the next four decades, estimates have been made of future vegetable acreage in the United States. Applying to these the estimated ratio of California acreage to that of the United States, California vegetable acreage for 1940 would become 561,000; for 1950, 687,000, for 1960, 801,000, and for 1970, 890,000 acres. These are conservative estimates and would be exceeded should California greatly expand her vegetable markets. To provide the area indicated above, it will be necessary to add during the decade 1930–1940 about 90,000 acres to the vegetable acreage. Between 1940 and 1950, 126,000 acres would be added, between 1950 and 1960 approximately 124,000, and between 1960 and 1970 the additional requirement would drop to 89,000. The lower increase for the last decade would result from the declining rates of population growth predicted.

Requirements for Irrigated Land for Vegetables.

Information needed to determine what part of this increase in vegetable acreage will be on irrigated land is not available. The 1909 irrigation census did not segregate vegetable acreage as in 1919. In that year about 53 per cent of all vegetables, except potatoes, were irrigated. The 91 per cent increase in vegetable acreage during the past decade has probably been to a large extent on irrigated land. For the purpose of filling a gap that would otherwise prevent the making of a total for all crops, an arbitrary assumption has been made that 75 per cent of the increase will be on irrigated land. Requirements for irrigated land for vegetables, therefore, will be as follows:

Decade	*Irrigated land to be added each decade in acres*
1930–1940	67,000
1940–1950	94,000
1950–1960	93,000
1960–1970	67,000

FUTURE LAND REQUIREMENTS FOR MISCELLANEOUS FIELD CROPS

Beans, sugar beets and cotton all will take second place in comparison with fruits, vegetables and the production of non importable dairy products in competing for irrigated land.

The utilization of cottonseed products by the live stock industry will tend to aid cotton in holding its own in this competition. However, the many possible substitutes for cottonseed products make it doubtful if this commodity, which has made such strides in recent years, will be able to continue its increase in acreage after the present period of overproduction has passed.

Sugar beet acreage in the future will be governed by success in combating the beet leafhopper and by the world wide economic situation with respect to sugar production, tariff regulations, etc.

Beans are largely grown on land of peculiar adaptation. There is some flexibility to this acreage, but the present bean acreage may be expected to remain fairly constant except for certain varieties grown on irrigated land and under varied climatic conditions. Much of the bean acreage is subject to serious erosion and soil fertility depletion.

It may be said that of the miscellaneous field crops, in the long run, land producing beets and cotton may be expected to give way to that used for producing fruit, vegetables and dairy products, while the bean acreage may continue about as at present. The rate of this shift will depend upon available lands and prices of the different competing crops. Prices in the long run, while subject to wide variations from normal, will be governed by the growth of population, while land use will be influenced by its adaption in comparison with competing areas. The controlling influence will be the character of available lands. Before summarizing the results of the various chapters, therefore, it will be well to compare land requirements for agriculture as a whole with estimates of available acreage.

CHAPTER VIII

LAND REQUIREMENTS IN COMPARISON TO LANDS AVAILABLE FOR IRRIGATION DEVELOPMENT

The foregoing chapters have discussed the major factors which will govern the demand for certain broad classes of agricultural commodities over the next four decades. In this chapter it is proposed to consider the possibilities of expansion from the standpoint of available irrigable lands. To do this it is necessary that we make use of all the knowledge we can obtain concerning acreages of irrigated and irrigable land. We must also have some knowledge of the conditions under which the unirrigated irrigable lands may become available for irrigation.

Irrigated Areas in the San Joaquin and Sacramento Valleys.

Earlier reports have given various estimates of agricultural, irrigable and irrigated land. A number of these have been very useful in our present analysis. Many different estimates of acreages of the different classes of land have been made. Differences in these estimates are due primarily to the different terms used to describe the different classes of land.

For example, irrigated land may or may not include grass lands that receive a very superficial irrigation at certain times during the year. Certain grain lands may receive a single flooding during the early part of the season when water supplies are plentiful. These, too, are often included. The difficult point is that such irrigation merges imperceptibly into the more intensive application of water to well prepared land. Then there is land which may not be irrigated in any given year, but which is prepared for irrigation and is irrigated when water is available. The intent of the owner may be to irrigate it in the future. He may have irrigated it in the past. So the question as to what constitutes irrigated land has introduced discrepancies into figures already subject to error because of the difficulty of collection.

The available data will serve as an approximate guide as to the amount of land which is irrigated, but for the purpose of determining trends which may be projected into the future they should be used cautiously because of the different meanings given to the term "irrigated land" in the different compilations. Rates of irrigation development have thus been obscured. Census figures are not indicative of the entire area which may rightfully be called irrigated, but they are a fair indication of the lands irrigated in any given census year. The State Engineer's office has estimated the areas of irrigated land in the San Joaquin and Sacramento valleys for the year 1929. These estimates are probably more comparable with the census figures for previous decades than they are with estimates of the entire area irrigated, now or in the past, and which has not been abandoned.

Rate of Irrigation Development in Different Parts of the San Joaquin Valley.

Table 71 is presented to show the difference between the rate of irrigation development in the different sections of the San Joaquin Valley. The trends indicated can not be used for projection into the future because of reasons already stated. Their usefulness, however, rests in the comparisons made possible between different sections. It will be noticed that the rate of development in recent years in the upper group of counties, where water shortage has been most pronounced, has been much slower than in the northern group of counties.

TABLE 71

IRRIGATED AREA IN ACRES IN THE SAN JOAQUIN VALLEY

Includes foothills on both sides of the valley

Counties	1909	1919	1929
Kern	190,034	223,593	201,600
Kings	190,949	187,868	138,000
Tulare	265,404	398,662	316,900
Fresno	402,318	547,587	501,800
Subtotals	1,048,705	1,357,710	1,158,300
Madera	38,705	100,220	83,300
Merced	151,998	212,851	236,300
Mariposa	376	66	
Stanislaus	84,015	197,249	264,800
San Joaquin	59,811	183,923	[3]410,300
Tuolumne	2,035	2,892	2,900
Calaveras	1,275	2,859	3,200
Amador	826	326	
Subtotals	339,041	700,386	[2]1,000,800
Alameda	[1]1,859	[1]9,346	[2]1,300
Contra Costa	[1]26,856	[1]33,079	[2]67,500
Subtotals	[1]28,715	[1]42,425	[2]68,800
Grand totals	1,414,360	2,097,336	2,227,900
Grand totals omitting Alameda and Contra Costa	1,385,645	2,054,911	2,159,100

[1] Includes entire county, a portion of which is outside of San Joaquin Valley.
[2] In San Joaquin Valley only. Contra Costa County includes 36,300 acres in San Joaquin Delta.
[3] Includes 158,000 acres in San Joaquin Delta.

Sources of data:

Irrigation acreages for 1909 and 1919 from U. S. Census, State Compendium for California, Washington Government Printing Office, 1924. For 1929, data have been supplied by the State Engineer and are the result of the 1929 crop survey.

We can not say that irrigation development has been practically stationary from 1909 to 1929 in the upper group, as is indicated by the figures, nor can we say there was an actual decrease of nearly 200,000 acres of irrigated land from 1919 to 1929 in that group, yet we can draw the conclusion that irrigation development in the upper group has been greatly retarded in comparison with the northern group of counties, where abundant water supplies have been developed by storage. This contrast is even more striking when it is realized that lands in this upper group of counties available for irrigation, which have not yet had water applied to them, include some of the finest soils of the San Joaquin Valley.

Irrigated Areas in the Sacramento Valley.

As in the case of the San Joaquin Valley, data on irrigated areas in the Sacramento Valley for the past three decades are useful in comparing the rates of growth in different sections, but they can not be used to indicate quantitatively how rapidly we may expect expansion to take place in the future, nor are they an accurate measure of rates of development in the past. Table 72 is presented to make possible a qualitative comparison of the rates of growth in different groups of counties.

TABLE 72

IRRIGATED AREA IN ACRES IN THE SACRAMENTO RIVER BASIN

County	1904	1919	1929
Glenn	3,881	116,901	
Colusa	4,276	44,097	
Subtotals	8,157	160,998	121,700
Yolo	11,774	42,462	
Solano	3,830	75,490	
Subtotals	15,604	117,952	151,270
Sacramento	83,843	72,000	121,400
El Dorado	3,121	9,771	11,080
Sierra			
Nevada	3,411	3,856	12,210
Placer	16,845	27,526	
Yuba	3,071	26,773	35,120
Subtotals	82,134	141,925	180,400
Butte	28,774	83,553	88,910
Sutter	1,173	47,200	101,790
Subtotals	29,947	140,854	190,690
Shasta	13,004	89,553	
Tehama	14,281	92,143	
Subtotals	47,285	75,638	75,680
Mountain Valleys		97,131	105,894
Grand totals	184,877	843,698	885,360

a Mountain valley areas are not obtainable from the 1919 Census. In the 1919 column they comprise those portions of the Sacramento watershed which are not included in the counties listed. In the 1929 column are included areas in the 1919 columns and additional areas which in succeeding years have been brought in the counties listed. The totals exhibited in the 1929 column include valley and foothill areas only.

Sources of data

For 1904 to 1919, from the U. S. Census. For 1929, estimated by the State Engineer's office.

Irrigable Land in the San Joaquin and Sacramento Valleys.

In 1929 the lands of the San Joaquin and Sacramento valleys were classified by the State Engineer. The original purpose of this classification was to determine how much water would ultimately be needed in different parts of the two valleys. This information was essential to the design and location of canals and the determination of the sizes of reservoirs. In the Sacramento Valley the land classification was made primarily to determine how much water would be available, in excess of the needs for that valley, for conveyance into the San Joaquin Valley. For purposes of making a safe estimate, therefore, the land classifica-

tion has purposely been generous. In other words, the area of irrigable land in the Sacramento Valley, as estimated from this classification, may be considered as a maximum.

For use in the water-supply analysis, the areas of irrigable land were computed for different service areas. County lines played no part in the location of these service-area boundaries. Table 73 gives the gross agricultural area and net irrigable area in the San Joaquin River Basin, exclusive of the Sacramento-San Joaquin Delta. Table 74 gives the gross agricultural area and net irrigable area in the Sacramento River Basin, including the Sacramento-San Joaquin Delta.

TABLE 73

GROSS AGRICULTURAL AND NET IRRIGABLE AREAS IN SAN JOAQUIN RIVER BASIN

Section	Gross agricultural area in acres[1]	Net irrigable area in acres[1]
Valley Floor	7,242,000	5,324,000
Foothill Areas	977,000	380,000
Totals	8,219,000	5,704,000

[1] Does not include San Joaquin and Contra Costa County lands lying in the Sacramento-San Joaquin Delta.

TABLE 74

GROSS AGRICULTURAL AND NET IRRIGABLE AREAS IN SACRAMENTO RIVER BASIN

Section	Gross agricultural area in acres	Net irrigable area in acres
Valley Floor	3,499,000	2,640,000
Foothill Area	2,099,000	922,000
Mountain Valleys	416,000	312,000
Sacramento-San Joaquin Delta [1]	412,000	392,000
Totals	6,426,000	4,266,000

[1] Includes 249,100 acres of gross agricultural land and 240,000 acres of net irrigable land in San Joaquin and Contra Costa counties lying in the Sacramento-San Joaquin Delta.

UNIRRIGATED IRRIGABLE LAND OF THE SAN JOAQUIN VALLEY

There are approximately 3,671,000 acres of land in the San Joaquin Valley, exclusive of the Sacramento-San Joaquin Delta, which is unirrigated and yet would be suitable for irrigation if water supplies were available and if economic conditions warranted its development. This figure has been derived by subtracting the area of irrigated land from

the total area of irrigable land. The distribution of this unirrigated irrigable land by county groups in the San Joaquin Valley is given in Table 75.

Just as the many statements giving the entire area of the San Joaquin Valley as irrigable land have been entirely misleading, the acreage of irrigable land must be considered as irrigable with many reservations. For this large body of soil may become irrigable only under certain specific conditions, many of which will involve the expenditure of large sums of money for various types of development. For this reason it has been necessary to pay particular attention to the elevation and situation of this unirrigated irrigable land area throughout different parts of the San Joaquin Valley.

TABLE 75

UNIRRIGATED IRRIGABLE LAND IN THE SAN JOAQUIN RIVER BASIN

[illegible]

County group	Irrigable area in acres	Irrigated area in acres	Unirrigated irrigable area in acres
Kern, Kings, Tulare, Fresno, Madera, Merced, Mariposa, Stanislaus, San Joaquin, Tuolumne, Calaveras, Alameda, Contra Costa	[illegible]	[illegible]	[illegible]
Totals	[illegible]	[illegible]	[illegible]

Sources of data and basis of estimate:

Irrigable areas from Table 74. Irrigated area supplied by the State Engineer's office 1928 survey. Unirrigated irrigable area is the difference between the irrigable and irrigated areas.

Lands Available for Immediate Development.

A small part of the total is available for development at the present time, having water supply and diversion works. This area lies for the most part in the northern portion of the San Joaquin Valley. It is estimated that within our presently organized irrigation districts of Merced, Stanislaus, San Joaquin and Contra Costa counties there are approximately 125,000 acres of irrigable land not now irrigated. The irrigation districts of these northern counties number more than a dozen and for the most part have adequate water supplies and diversion works for the delivery of water to this undeveloped area.

South of Merced County there are extensive tracts of unirrigated irrigable land for which water supplies are not available. About 712,000 acres of this land are so situated that they could be irrigated at moderate costs, in addition to those involved in the construction of a main canal into Tulare County to carry water supplies from new storage in the San Joaquin Valley supplemented by water imported from the Sacramento River. This area of unirrigated irrigable land stands ready to share immediately the benefits of new water supply

development with the areas already cropped in Fresno, Tulare and Kern counties, for which there now is so urgent an appeal for additional water supplies. These include irrigated lands in the Alta and Foothill districts; the Kaweah Delta area; the Exeter and Lindsay area; the Tule River and Deer Creek area, and the Earlimart area, all in eastern Fresno and Tulare counties, embracing about 260,000 acres of irrigated land for which there has been an increasing annual shortage of water. There are also some irrigated lands south of these in Kern County, involving approximately 60,000 acres, on which the water supply is critical. In Madera County about 80,000 acres of irrigated lands are also deficient in their water supply.

If water is provided for areas now planted to intensive crops in Kern County, for which there is a deficiency, and to the undeveloped lands adjacent to them, additional areas, amounting to some 325,000 acres, would be made available immediately for development under irrigation. In other words, the importation of water into the San Joaquin Valley on a scale that would provide not only for the deficiencies of lands now irrigated, but also for the undeveloped lands so situated that they could easily avail themselves of the new water supply, would mean that more than a million acres of fertile soil, including the 712,000 mentioned above, would become immediately subject to development.

But we are a long way from accounting for all of the 3,671,000 acres given as the estimated total of unirrigated irrigable land in the San Joaquin Valley. The balance is subject to development, but at a much greater cost for additional water supplies or for diversion works. Some of this remaining area is so situated, either in elevation or in distance from water supplies that may become available, that the chances for its becoming irrigated land are very remote indeed. It is estimated there are about 1,094,000 acres so situated. But in the intermediate class are 1,180,000 acres. This includes lands which could be irrigated by water from the adjacent mountains, should imported water become available to be substituted for the irrigation of lands now served by these supplies. But to make this acreage available, storage, diversion works and pumping plants must be constructed at costs additional to those incident to importing the supplies from the Sacramento Valley.

In Table 76 the estimated segregation of the unirrigatd irrigable area of the San Joaquin Valley has been summarized so that the reader may obtain at a glance the relative magnitude of the different areas subject to development under the conditions described.

This segregation was the result of approximate estimates made in the field. Contour maps and data obtained from local authorities, together with the land classification made by the State Engineer's office, have been the basis of the estimates. It must be recognized that there is a twilight zone between each of the classifications as to remoteness of development which time alone can place on a definite basis. What contour shall mark the limit of economic development can only be a matter of arbitrary judgment at the present. The criteria which have been used in the segregation, however, have been fairly definite. In Kern County all those lands lying above apparently feasible diversion from the Kern River were placed in the remote class. Also the irrigable lands on the west side of the valley miles removed from sources of supply and separated from them by the trough of the valley were placed in this group. In Fresno County a large body of splendid

soil lying above the pumping lifts, determined as feasible in the investigations for the San Joaquin Water Storage District, were thrown into the class having remote possibilities of development. Further north existing high line canals of pumping projects show the limits worked out as practical. It has been these limitations which have been used in making the segregation.

TABLE 76

ESTIMATED AREA OF UNIRRIGATED IRRIGABLE LAND IN THE SAN JOAQUIN VALLEY IN ORDER OF AVAILABILITY FOR DEVELOPMENT, 1929

Classification under which lands may be irrigated	Acres
Now available for development with existing diversion works and water supplies	125,000
Additional area which would immediately become available for development if an ample water supply should be provided for delivery under the present and earlier canals	715,000
Additional areas which would immediately become available if an ample water supply should be furnished by storage in Friant Reservoir	750,000
Areas which, by the construction of storage pumping systems, through works in addition to the proposed Stake Plan, would become available for development upon delivery of an ample water supply to the northern boundary of Tulare County	1,185,000
Additional areas which by the construction of storage in Friant reservoir in addition to the proposed Stake Plan, would become available for development upon delivery of an ample water supply at the south end of Tulare County	355,000
Irrigable areas in the San Joaquin Valley having remote possibilities of development because of distance from sources of diversion	1,080,000
Total unirrigated irrigable land in the San Joaquin Valley not otherwise classified	4,071,000

Sources of data and basis of estimate:

These estimates are based upon the land classification and acreages of proposed areas made by the State Engineer in 1924 and field investigations made by his expert during the summer of 1929.

ESTIMATED AREA OF UNIRRIGATED IRRIGABLE LAND IN THE SACRAMENTO RIVER BASIN

In the Sacramento River basin it is estimated there are approximately 3,190,000 acres of unirrigated irrigable land. Even more important than in the San Joaquin Valley is the segregation of this area into the portions which may be available for irrigation development under different conditions. Much of this 3,190,000 acres has such remote possibilities for development that the presentation of the acreage without further qualification would be entirely misleading.

It is estimated that 500,000 acres of unirrigated irrigable land in the Sacramento Valley, lying below the proposed major reservoir system and contained within organized irrigation and reclamation districts, is so situated that it can be turned into irrigated farms without the expenditure of large sums of money in building major works for supplying water and diverting it to the individual farms. The installation of farm laterals, pumping plants or even minor distribution systems may be required, however. The fact must not be overlooked that of the irrigation and reclamation works serving these lands many have not been paid for. It must also be realized that some of this area has a rather limited crop adaptation. Considerable amounts of capital must be provided in addition to the cost of those irrigation and reclamation works before these lands may be utilized for producing intensive crops under irrigation. If it were not for the outstanding bonded indebtedness and the sums required for turning the land into improved farms, the rate at which these lands would be subdivided and settled would be much more rapid.

Notwithstanding the depressed agricultural conditions characteristic of the post-war years, there is still some tendency to bring these lands under more intensive cultivation, especially in the area subject to irrigation by individual pumping systems. Of the 500,000 acres in the Sacramento Valley which is subject to early development, approximately 260,000 acres lie within reclamation projects. Some of these are equipped to deliver water to the farms within their boundaries. Some are merely projects for the control or prevention of floods. There are about 300,000 acres within organized irrigation districts in the Sacramento Valley which are not now irrigated, but which are irrigable. This is a smaller acreage than has been reported as irrigable by the various districts, but it is the area estimated as being irrigable from data compiled under the direction of the State Engineer on classes of land within these districts, crops grown and estimates as to the amount of irrigable land in different parts of the Sacramento Valley and with respect to different classes of land.

There are approximately 1,030,000 acres of unirrigated irrigable land lying above the proposed major reservoir system. Most of this land will require construction of storage and distribution works before a water supply can be obtained.

Inasmuch as there are approximately 1,660,000 acres of irrigable land lying below the proposed reservoir system, in addition to the 500,000 acres mentioned as being immediately available for development, most of the unirrigated irrigable land situated above the reservoir system may be considered as having remote chances for development. There are, however, isolated tracts in portions of this area which may have local opportunities for early development. The area lying in the intermediate class between the lands having remote possibilities for development and those now ready for settlement requires construction in addition to the major foothill reservoirs for its development.

It may be readily seen, therefore, that our supply of land within the interior valleys available for early development is somewhat limited, and that further irrigation expansion is contingent upon the expenditure of rather large sums of money.

A summary of the acreages of unirrigated irrigable land in the Sacramento River Basin, giving the segregation as described above, is presented in Table 77. Before it was possible to construct this table the information given in Table 78 was necessary. This table shows the total irrigable area in different parts of the Sacramento Valley and also shows that part which is irrigated and which is irrigable and not irrigated. These estimates have been made on the basis of data compiled by the State Engineer's office.

LAND REQUIREMENTS AND LAND AVAILABLE

In the two interior valleys combined, including adjacent plains and foothills, there are approximately 6,900,000 acres of unirrigated irrigable land. If these lands were known to be of the same grade as those already under irrigation, if they were all adaptable to the crops which will be needed, and if they could be irrigated at costs comparable to prevailing costs for water, the problem of estimating land requirements for the future would be somewhat simplified.

TABLE 77

ESTIMATED AREA OF UNIRRIGATED IRRIGABLE LAND IN THE SACRAMENTO RIVER BASIN, 1929

Conditions under which land may be irrigated	Acres	
Land within irrigation or reclamation projects lying below the proposed major reservoir system subject to early development:		
(a) Unirrigated irrigable land in irrigation districts existing (about)	300,000	
(b) Unirrigated irrigable land in reclamation districts not now intensively irrigated	200,000	
Subtotal	500,000	
Deduct for overlap	60,000	
		500,000
Unirrigated irrigable land lying below the proposed major reservoirs of the State Plan which will require some construction of diversion works or reservoirs in addition to those under immediate consideration		1,000,000
Irrigable lands lying above the proposed major reservoir system which are not now irrigated		1,000,000
Total unirrigated irrigable land in the Sacramento River Basin		3,150,000

Sources of data and basis of estimate:

These estimates are based upon the land classification and estimates of irrigated areas made by the State Engineer in 1929 and field investigations made for the report during the summer of 1930.

TABLE 78

UNIRRIGATED IRRIGABLE LAND IN THE SACRAMENTO RIVER BASIN
Including entire Sacramento-San Joaquin Delta

Gross	Irrigable area in acres	Irrigated area in acres	Unirrigated irrigable area in acres
Valley Floor	2,440,000	265,000	2,074,000
Foothill area	621,000	65,000	556,000
Mountain Valleys	312,000	138,000	174,000
Sacramento and San Joaquin Delta	832,000	695,000	85,000
Totals	4,290,000	1,020,000	3,160,000

Summary of data and basis of estimate:

Irrigable areas from Table 74. Irrigated area from Tables 71 and 73. Unirrigated irrigable area is the difference between the irrigable and irrigated areas.

Land Requirements.

It is estimated that the additional requirements for irrigated land for fruits, vegetables and alfalfa, or a desirable substitute, during the decade 1930–1940 will be a little in excess of the equivalent of a half million acres,* that the additional requirement for the decade 1940-1950 will be about three-quarters of a million acres, and that during the next 40 years, the period from 1930-1970, about two and a half million acres,

* At the same time the lands of the two counties were classified a crop survey was made. This was done to ascertain, among the constituents to measure duty used. It has been noted in Chapter IV that the gross acreages of fruit trees determined were about 25 per cent greater than the acreages included in the analyses of requirements for irrigable fruit acreage. Attention was also called to the fact that this difference should not indicate that either one is seriously in error, for one gives annual area of crop land while the other gives net harvested area of the perennial crops only. Gross acreages on the other hand, as originally determined in the 1929 land classification, have been reduced by various percentages to determine net irrigable areas. Estimated requirements for harvested acreage should probably be increased about 25 per cent to make them comparable to these estimates of irrigable acreage. On this basis the estimates of requirements for irrigated land during the next four decades have been made.

having the same productivity as our present area of irrigated land, will be required for these intensive crops. This is on the assumption that we maintain our present per capita production of butterfat. It will necessitate, however, further reduction in feed requirements per pound of butterfat produced. The estimate also recognizes that we have more fruit acreage in California today than is really good for us and that there also is an excess in orchard and vineyard acreage in the United States. Additional land will not be *required* for the production of miscellaneous field crops, grain and other crops, but these will, of course, be produced if the land is available in excess of requirements for fruits, vegetables and roughage for live stock. Adaptation of land for different crops will govern the amount of these that will be grown. Rice will probably occupy most of the lands peculiarly adapted to its growth and to which an adequate water supply may be delivered. The acreage of irrigated grain will be influenced by the same considerations.

Crop Adaptation.

Even lands adapted to rice culture have some alternative uses. When the fruits are considered there is more flexibility until the orchard is planted, but after that a change is most difficult. Over long periods of time even fruit lands will tend to produce crops physically and economically best adapted to them. With respect to the annual crops, including those more or less intensively cultivated, there is a wide degree of choice as to crops and land, so that while there are certain definite limitations to land which can be used to produce alfalfa there is not quite such definite limitations to land that can be used to produce butterfat.

We have rather extensive areas of heavy soils which are limited in their adaptation, but which have been included in the estimated acreages of unirrigated irrigable lands. There also are other extensive soil types, the use of which will be limited to specific crops. The question of adaptation, therefore, becomes particularly important when it comes to interpreting the extent to which 625,000 acres of land now available for more intensive cultivation within the two interior valleys and certain other lands subject to moderate costs of development may serve in supplying the half-million acres which it is estimated can be safely added to our irrigated acreage during the latter part of the present decade for the production of certain kinds of fruits, vegetables and roughage.

Since 500,000 acres of this immediate available area lies within irrigation and reclamation districts of the Sacramento Valley, it might be possible to draw certain conclusions concerning the adaptability of these lands from the results of the water supply investigations.

Land Utilization in Sacramento Valley Irrigation Districts.

It is estimated that there are 424,000 acres which are irrigable in the irrigation districts of the Sacramento Valley, of which approximately 124,000 were irrigated in 1929, leaving 300,000 acres of unirrigated irrigable lands. In these same irrigable districts there are 149,700

acres classified as first class* and 122,700 as second class land. There are also 112,600 acres of third class land. On the valley floor much of the third class land is on the heavy soils adapted to rice culture. Within these irrigation districts are 75,370 acres of orchards, vineyards, alfalfa, sudan grass and truck crops probably growing for the most part on first class land. Some of it, however, is on second class and some on third class land. Most of the rice is found on second and third class land. Grain is found growing on all classes except the fourth and fifth. The conclusion that can be drawn from this incomplete picture is that instead of the unirrigated irrigable land in these districts having 35 per cent of its irrigable area on first class land, as now is the case for the total area of irrigable land in the Sacramento Valley, the distribution is more likely to include only 30 per cent of first class land, with the balance distributed among the lower classes. In other words, the average quality will be lower. A superficial examination of the soil map in the field where growing crops may be observed will lead to the same conclusion. Even the first class land within these districts which is yet unirrigated probably has a lower average productivity than the first class cropped land. This can not be said of all of the uncropped land, however, for there are some very productive soils yet uncropped under intensive irrigation. A similar analysis of the reclamation districts will lead to the conclusion that the 260,000 acres of irrigable land uncropped to intensive agriculture have not the same average productivity as the lands already in crop. There are thousands of acres of unirrigated land in the two valleys outside of projects which include some of the finest soils of the state.

One of the most serious questions must remain temporarily unanswered, however. That is to what extent will lands now available for irrigation meet the needs of the near future? When we consider present surpluses, the lands now available outside of the two valleys, and the lands to be irrigated in the southeastern part of the state by Boulder Canyon water, it seems that we might eke out the current decade with the land we now have under irrigation.

If the same ratio between the irrigable area reported by irrigation districts and irrigable areas indicated by land classifications in the interior valleys exists for the irrigation districts of the entire state, we have within irrigation districts of the state a little more than a million acres of irrigable land. Less than half of this area, however, can be served by completed water supplies and diversion works.

Economic soil and survevs in the area to be served by Boulder Canyon have not progressed far enough to predict the addition to be made from that source, but preliminary statements of those intimately in touch with that development indicate a possible addition of 100,000 acres not now irrigated.

We can not tell just when and how all of these areas may become available. We are also at a loss to know just what the adaptation of the lands will be. If the present utilization of lands in the Sacramento

* Classes of land referred to are those used in the land classification made by the State Engineer in 1920.

Valley is an indication of crop adaptation for all of the irrigable area, then only 60 per cent of the irrigable area will be adapted to the production of orchards, vineyards, alfalfa and vegetables. About 30 per cent of the cropped area is in orchard and vineyard, while an equal amount is in alfalfa and truck crops. Of course, present utilization is not an accurate indication of future adaptation of the lands unirrigated at present. The fact remains that our total area of unirrigated irrigable land is not available for producing fruit, vegetables and butterfat.

AN IRRIGATION DEVELOPMENT POLICY

The increase predicted in irrigated acreage for the future can result in a perpetual condition of oversupply of agricultural production; or our policy of irrigation development may, if carefully drawn up, assist in bringing about a stabilization of expansion so that it will be more nearly in accordance with the condition of the market. On the other hand, a period of undersupply with consequent high prices might be as fatal to the California industry as an oversupply. The generation of another vicious cycle of over-expansion would surely result from abnormally high prices. There is always danger, during such periods of the development, of competing areas which remain in production to aggravate the situation when prices fall again. Our policy must not be a narrow one, therefore, of looking on only one side during these pessimistic times. We can plan now for the next period of over-expansion much more easily than we can cure the evils of the present one. It is just as important to prevent a period of abnormally high prices as one of abnormally low prices. We must progress with irrigation development as nearly as possible in accordance with the demand for the products of irrigated land.

APPENDIX A

APPENDIX A

Tables 1A to 9A give estimates of net effective immigration showing details of computation.

In each of the tables except for the decade 1920-1930 columns 2 and 6 give population by age, sex and nativity obtained by adjusting populations for the respective age groups from the U. S. Department of Commerce, Bureau of the Census, Census of Population for 1880, 1890, 1900, 1910 and 1920. This adjustment was made by distributing numbers of persons of unknown age among specified age groups.

For Tables 1A to 6A, inclusive, survivors per 100,000 given in column 3 for decades 1880 to 1890, 1890 to 1900, 1900 to 1910, were computed from Glover, James W., Department of Commerce, Bureau of the Census, U. S. Life Tables 1890, 1901 1910 and 1901 to 1910, Table 19, page 88; Table 21, page 92, Table 23, page 96, Table 25, page 100, United States Government Printing Office, 1921.

In each of the above cited life tables column 2, giving values for l_x, have been used. Data for computing survivors for the age group 0–4, foreign, not being available, the same factor was used for this group as for native born. This applies also to the decade 1910 to 1920.

In Tables 7A and 8A, survivors per 100,000 for the decade 1910 to 1920 were computed from the *Life* Tables cited, Table 20, page 90; Table 22, page 94; Table 24, page 98; Table 26, page 102. Survivors per 100,000 for the decade 1920 to 1930, as shown in Table 9A, were computed from Fondray, Elbert, Department of Commerce, Bureau of the Census, U. S. Abridged Life Tables 1919-1920, Table 5, page 16; Life Table 5 for California, Table 6, page 18; Life Table 6 for California. Given in Column 5 survivors per 100,000 represent the numbers living at the end of a decade out of 100,000 at the beginning of the decade. Net effective immigration given in Column 7 has been computed by subtracting the survivors in each particular age group from the total recorded census population for that age group at the end of the decade.

TABLE 1A

NET EFFECTIVE IMMIGRATION OF NATIVE-BORN PERSONS INTO CALIFORNIA, COMPUTED ACCORDING TO AGE, SEX AND NATIVITY, 1880-1890

1	2		3		4	5		6		7	
Age in 1880	Population in 1880		Survivors per 100,000		Age in 1890	Survivors in 1890 from 1880 population		Population in 1890[1]		Net effective immigration 1880 to 1890[1]	
	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female
0- 4	46,975	45,637	90,612	91,563	10-14	42,565	41,787	53,426	52,088	10,861	10,301
5- 9	44,393	43,438	96,777	96,909	15-19	42,962	42,095	51,416	49,603	8,454	7,508
10-14	38,585	37,916	95,845	95,891	20-24	36,982	36,358	53,105	44,817	16,123	8,459
15-19	39,209	33,531	93,968	94,139	25-29	36,844	31,566	51,966	35,285	15,122	3,719
20-24	41,082	27,638	92,679	93,003	30-34	38,074	25,704	47,093	28,415	9,019	2,711
25-29	35,696	18,235	91,825	92,453	35-39	32,778	16,859	36,217	20,214	3,439	3,355
30-34	30,998	14,005	91,066	92,056	40-44	28,229	12,892	30,240	15,935	2,011	3,043
35-39	23,348	11,976	90,099	91,276	45-49	21,036	10,931	21,296	12,926	260	1,995
40-44	22,816	9,890	88,627	89,919	50-54	20,221	8,893	18,716	10,912	**1,505**	2,019
45-49	18,053	7,640	86,208	87,663	55-59	15,563	6,697	15,077	7,547	**486**	850
50-54	17,260	6,056	81,986	84,077	60-64	14,151	5,092	15,114	6,169	963	1,077
55-59	9,031	3,487	75,012	78,351	65-69	6,774	2,732	7,708	3,721	934	989
60-64	7,389	2,629	64,832	69,390	70-74	4,790	1,824	4,224	2,386	**566**	562
65-69	3,195	1,594	51,518	56,646	75-79	1,646	903	1,917	1,264	271	361
70-74	1,826	1,112	35,605	40,515	80-84	650	450	825	669	175	219
75-79	796	606	20,493	24,615	85-89	163	149	260	256	97	107
80-84	366	322	9,728	12,365	90-94	35	40	84	91	49	51
85-89	80	82	3,694	4,542	95-99	3	4	15	20	12	16
90-94	38	40	1,003	1,005	100+	0	0	24	30	24	30
95-99	12	9	132	724							
100+	29	22	0	0							
Totals	381,177	265,865				343,466	244,976	408,723	292,348	65,257	47,372
Total net effective immigration of native-born persons[1]											112,629

Sources of information and bases of estimate:

For details see discussion and footnote on page 37. Items in column 2 are census figures. Column 3 was computed by method given in footnote on page 37. Column 5 = column 2 x column 3 ÷ 100,000. Items in column 6 are census figures adjusted. Column 7 = Column 6 — column 5. Figures in bold face represent net decrease for the decade.

[1] Children under 10 years of age not included.

TABLE 2A

NET EFFECTIVE IMMIGRATION OF FOREIGN-BORN PERSONS INTO CALIFORNIA, COMPUTED ACCORDING TO AGE, SEX AND NATIVITY, 1880-1890

1 Age in 1880	2 Population in 1880		3 Survivors per 100,000		4 Age in 1890	5 Survivors in 1890 from 1880 population		6 Population in 1890		7 Net effective immigration 1880 to 1890	
	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female
0–4	396	400	89,812	91,852	10–14	357	385	4,260	4,412	2,903	3,747
5–9	1,244	1,131	96,580	96,968	15–19	1,092	1,080	9,407	9,934	5,255	5,629
10–14	2,136	2,178	95,728	96,139	20–24	2,046	2,066	15,791	16,283	6,488	8,187
15–19	4,098	4,318	94,160	94,969	25–29	3,864	3,933	25,197	25,241	9,286	8,961
20–24	7,442	8,247	93,973	95,321	30–34	6,919	7,848	29,795	31,251	12,956	12,268
25–29	10,910	9,274	93,078	94,500	35–39	15,000	8,652	21,432	19,157	5,054	3,685
30–34	10,789	11,434	90,199	90,790	40–44	17,854	13,302	31,045	23,903	4,251	2,473
35–39	10,089	10,248	87,868	88,302	45–49	17,243	10,964	18,040	11,857	950	560
40–44	11,951	11,241	84,984	87,171	50–54	15,192	8,961	13,322	8,668	911	805
45–49	10,423	8,207	80,087	80,875	55–59	12,240	8,018	11,266	8,481	941	137
50–54	11,761	8,302	73,950	76,197	60–64	8,821	4,850	11,900	5,296	1,095	982
55–59	6,846	5,044	69,181	69,633	65–69	4,591	2,149	5,467	3,010	1,449	832
60–64	5,603	3,892	61,086	58,318	70–74	3,344	1,514	4,043	1,717	330	123
65–69	3,243	1,541	45,147	45,958	75–79	1,462	840	1,777	848	146	284
70–74	1,965	778	31,401	37,412	80–84	535	283	699	414	101	161
75–79	630	395	18,045	20,691	85–89	98	77	123	134	18	77
80–84	225	248	9,261	10,214	90–94	21	23	44	56	23	33
85–89	78	68	5,770	4,284	95–99	9	0	15	18	15	18
90–94	30	27	1,979	1,500	100 +	0	0	10	7	10	7
95–99	9	8		110							
100 +	2	9		0							
Totals	140,999	80,858				113,517	88,715	175,400	107,857	53,905	54,564
Total net effective immigration of foreign-born persons											108,837

Sources of information and bases of estimate:

For details see discussion and footnote on page 37. Items in column 2 are census figures. Column 3 was computed by method given in footnote on page 37. Column 5 = column 2 x column 3 ÷ 100,000. Items in column 6 are census figures adjusted. Column 7 = column 6 — column 5. Figures in bold face represent net decrease for the decade.

(Children under 10 years of Age not included)

TABLE 3A

NET EFFECTIVE IMMIGRATION OF NATIVE-BORN PERSONS INTO CALIFORNIA, COMPUTED ACCORDING TO AGE, SEX AND NATIVITY, 1890-1900

1	2		3		4	5		6		7	
Age in 1890	Population in 1890		Survivors per 100,000		Age in 1900	Survivors in 1900 from 1890 population		Population in 1900[1]		Net effective immigration 1890 to 1900[1]	
	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female
0- 4	53,934	51,707	90,612	91,563	10-14	48,871	47,344	61,778	60,436	12,907	13,092
5- 9	54,831	53,028	96,777	96,909	15-19	53,064	51,389	57,642	58,257	4,578	6,868
10-14	53,426	52,088	95,845	95,891	20-24	51,206	49,948	57,185	58,027	5,979	8,079
15-19	51,416	49,603	93,968	94,139	25-29	48,315	46,696	51,578	50,511	3,263	3,815
20-24	53,105	44,817	92,679	93,003	30-34	49,217	41,681	45,846	41,720	**3,371**	39
25-29	51,966	35,285	91,825	92,453	35-39	47,718	32,622	41,014	35,701	**6,704**	3,079
30-34	47,093	28,415	91,066	92,056	40-44	42,886	26,158	34,546	28,464	**8,340**	2,306
35-39	36,217	20,214	90,099	91,276	45-49	32,631	18,450	24,145	20,168	**8,486**	1,718
40-44	30,240	15,935	88,627	89,919	50-54	26,801	14,329	19,080	16,022	**7,721**	1,693
45-49	21,296	12,926	86,208	87,663	55-59	18,359	11,331	14,540	12,386	**3,819**	1,055
50-54	18,716	10,912	81,986	84,077	60-64	15,344	9,174	13,906	10,265	**1,438**	1,091
55-59	15,077	7,547	75,012	78,351	65-69	11,310	5,913	11,904	7,311	594	1,398
60-64	15,114	6,169	64,832	69,390	70-74	9,799	4,281	8,387	4,765	**1,412**	484
65-69	7,708	3,721	51,518	56,646	75-79	3,971	2,108	4,201	2,512	230	404
70-74	4,224	2,386	35,605	40,515	80-84	1,504	967	1,680	1,250	176	283
75-79	1,917	1,264	20,493	24,615	85-89	393	311	480	438	87	127
80-84	825	669	9,728	12,365	90-94	80	83	125	128	45	45
85-89	260	256	3,694	4,542	95-99	10	12	29	23	19	11
90-94	84	91	1,003	1,005	100+	1	1	18	21	17	20
95-99	15	20	132	724							
100+	24	30	0								
Total	517,488	397,083				461,480	362,798	448,084	408,405	**13,396**	45,607
Total net effective immigration of native-born persons[1]											32,211

Sources of information and bases of estimate:

For details see discussion and footnote on page 37. Items in column 2 are census figures adjusted. Column 3 was computed by method given in footnote on page 37. Column 5 = column 2 x column 3 ÷ 100,000. Items in column 6 are census figures adjusted. Column 7 = column 6 — column 5. Figures in boldface represent net decrease for the decade.

[1] Children under 10 years of age not included.

TABLE 4A

NET EFFECTIVE INMIGRATION OF FOREIGN-BORN PERSONS INTO CALIFORNIA, COMPUTED ACCORDING TO AGE, SEX AND NATIVITY, 1890-1900

Age in 1890	2 Population in 1890		3 Survivors per 100,000		4 Age in 1900	5 Survivors in 1900 from 1890 population		6 Population in 1900		7 Net effective immigration 1890 to 1900	
	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female
0- 4	809	708	90,612	91,563	10-14	732	703	2,923	2,622	2,191	1,919
5- 9	2,946	2,218	96,265	96,865	15-19	2,285	2,148	8,111	4,879	5,826	2,731
10-14	3,756	3,112	95,738	96,320	20-24	3,112	3,017	13,458	8,756	10,346	5,739
15-19	5,417	4,924	94,382	94,909	25-29	4,981	4,673	20,897	17,579	14,716	7,906
20-24	14,723	10,255	89,373	93,921	30-34	14,690	9,629	28,088	14,570	13,398	4,741
25-29	22,697	12,301	92,078	92,350	35-39	20,318	11,355	32,801	14,821	12,483	3,266
30-34	21,725	11,251	90,100	90,780	40-44	19,576	10,197	29,493	14,499	9,917	3,802
35-39	21,502	12,147	87,809	89,292	45-49	18,888	10,987	26,998	13,189	7,291	2,202
40-44	21,943	12,805	84,884	87,171	50-54	17,804	11,188	22,557	13,506	4,893	1,318
45-49	18,086	11,527	80,287	82,678	55-59	14,520	9,560	16,450	9,648	1,930	119
50-54	13,923	10,008	73,845	76,287	60-64	11,470	8,159	13,268	8,721	1,798	562
55-59	11,260	6,781	66,181	68,603	65-69	7,482	4,954	10,597	5,966	3,115	1,011
60-64	11,801	5,702	58,095	58,515	70-74	6,723	3,872	6,940	3,713	218	841
65-69	5,497	2,929	45,497	45,998	75-79	2,719	1,345	4,120	1,865	401	520
70-74	3,952	1,717	31,581	32,512	80-84	987	950	1,110	824	147	294
75-79	1,177	849	18,545	20,001	85-89	218	170	211	251	93	81
80-84	486	414	9,581	10,214	90-94	46	42	73	67	27	25
85-89	143	154	3,770	4,286	95-99	5	7	17	23	12	16
90-94	49	55	1,079	1,300	100 +	0	1	14	15	14	14
95-99	15	15	0	119							
100 +	10	7	0	0							
Total	182,474	119,653				147,682	91,517	288,485	175,378	80,800	43,861
Total net effective immigration of foreign-born persons											124,864

Sources of information and bases of estimate:

For details see discussion and footnote on page 97. Items in column 2 are census figures adjusted. Column 3 was computed by method given in footnote on page 97. Column 5 — column 2 × column 3 ÷ 100,000. Items in column 6 are census figures adjusted. Column 7 = column 6 − column 5. Figures in boldface represent net decrease for the decade.

Children under 10 years of age not included.

TABLE 5A

NET EFFECTIVE IMMIGRATION OF NATIVE-BORN PERSONS INTO CALIFORNIA, COMPUTED ACCORDING TO AGE, SEX AND NATIVITY, 1900-1910

1	2		3		4	5		6		7	
Age in 1900	Population in 1900		Survivors per 100,000		Age in 1910	Survivors in 1910 from 1900 population		Population in 1910[1]		Net effective immigration 1900 to 1910[1]	
	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female
0- 4	63,307	62,039	90,612	91,563	10-14	57,364	56,805	81,300	79,908	23,936	23,103
5- 9	68,362	67,068	96,777	96,909	15-19	66,159	64,995	86,433	85,982	20,274	20,987
10-14	61,778	60,436	95,845	95,891	20-24	59,211	57,953	91,206	85,977	31,995	28,024
15-19	57,642	58,257	93,968	94,139	25-29	54,165	54,843	89,287	80,785	35,122	25,942
20-24	57,185	58,027	92,679	93,003	30-34	52,998	53,967	80,802	72,506	27,804	18,539
25-29	51,578	50,511	91,825	92,453	35-39	47,361	46,699	72,000	64,952	24,639	18,253
30-34	45,846	41,720	91,066	92,056	40-44	41,750	38,406	60,336	51,947	18,586	13,541
35-39	41,014	35,701	90,099	91,276	45-49	36,953	32,586	49,972	42,601	13,019	10,015
40-44	34,546	28,464	88,627	89,919	50-54	30,617	25,595	40,909	34,509	10,292	8,914
45-49	24,145	20,168	86,208	87,663	55-59	20,815	17,680	26,395	22,842	5,580	5,162
50-54	19,080	16,022	81,986	84,077	60-64	15,643	13,471	22,637	18,685	6,994	5,214
55-59	14,540	12,386	75,012	78,351	65-69	10,907	9,704	16,433	13,632	5,526	3,928
60-64	13,906	10,265	64,832	69,390	70-74	9,015	7,123	11,512	9,045	2,497	1,922
65-69	11,904	7,311	51,518	56,646	75-79	6,133	4,141	7,417	5,593	1,284	1,452
70-74	8,387	4,765	35,605	40,515	80-84	2,986	1,931	3,544	2,596	558	665
75-79	4,201	2,512	20,493	24,615	85-89	861	618	1,140	911	279	293
80-84	1,680	1,250	9,728	12,365	90-94	163	155	235	224	72	69
85-89	480	438	3,694	4,542	95-99	18	20	50	43	32	23
90-94	125	128	1,003	1,005	100+	1	1	9	6	8	5
95-99	29	23	132	724							
100+	18	21	0	0							
Totals	579,753	537,512				513,120	486,693	741,617	672,744	228,497	186,051
Total net effective immigration of native-born persons[1]											414,548

Sources of information and bases of estimate:

For details see discussion and footnote on page 37. Items in column 2 are census figures adjusted. Column 3 was computed by method given in footnote on page 37. Column 5 = column 2 × column 3 ÷ 100,000. Items in column 6 are census figures adjusted. Column 7 = column 6 — column 5. Figures in boldface represent net decrease for decade.

[1] Children under 10 years of age not included.

TABLE 6A

NET EFFECTIVE IMMIGRATION OF FOREIGN-BORN PERSONS INTO CALIFORNIA, COMPUTED ACCORDING TO AGE, SEX AND NATIVITY, 1900-1910

1 Age in 1900	2 Population in 1900		3 Survivors per 100,000		4 Age in 1910	5 Survivors in 1910 from 1900 population		6 Possessed in 1910		7 Net effective immigration 1900 to 1910	
	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female
0- 4	451	447	89,612	91,563	10-14	874	849	6,986	6,879	3,014	3,000
5- 9	1,294	1,144	96,264	96,865	15-19	1,148	1,157	19,695	9,204	14,993	7,947
10-14	2,822	2,932	95,745	95,390	20-24	2,700	2,797	49,258	17,255	42,963	14,257
15-19	8,811	4,979	94,999	94,089	25-29	7,949	4,688	84,005	19,980	69,774	15,584
20-24	13,458	6,726	93,873	93,921	30-34	12,636	6,197	71,981	21,278	55,438	14,681
25-29	20,901	12,276	92,975	92,250	35-39	19,458	11,327	62,944	23,824	37,986	10,447
30-34	18,088	14,710	92,199	91,746	40-44	25,713	13,646	61,642	21,693	44,197	7,986
35-39	15,501	14,643	92,802	92,392	45-49	28,801	12,581	56,716	18,204	27,915	5,558
40-44	10,430	13,102	91,884	87,171	50-54	23,093	10,898	29,242	15,139	6,207	4,004
45-49	7,606	9,756	90,287	82,678	55-59	29,004	10,680	25,175	13,695	204	3,075
50-54	5,547	7,200	79,680	79,287	60-64	16,668	9,087	11,473	12,009	4,870	2,749
55-59	3,860	5,048	69,181	68,695	65-69	13,667	6,622	15,587	8,734	5,756	5,232
60-64	2,408	3,271	59,600	58,519	70-74	9,324	5,180	8,847	5,161	477	3,261
65-69	1,247	1,952	43,487	43,096	75-79	3,759	2,097	5,347	3,478	817	1,151
70-74	636	1,175	31,541	33,417	80-84	2,093	1,211	2,429	1,521	229	190
75-79	335	1,016	18,345	29,001	85-89	879	871	808	674	259	262
80-84	138	838	5,201	10,214	90-94	195	84	295	191	120	107
85-89	111	251	3,779	4,284	95-99	12	11	53	45	41	34
90-94	29	47	1,079	1,309	100 +	1	1	29	29	28	24
95-99	17	20	0	119							
100 +	14	15	0	0							
Totals	240,193	135,099				187,988	105,692	565,461	195,951	305,441	98,652
Total net effective immigration of foreign-born persons											404,374

Sources of information and bases of estimate:

For details see discussion and footnote on page 87. Items in column 2 are census figures adjusted. Column 3 was computed by method given in footnote on page 87. Column 5 = column 3 × column 2 ÷ 100,000. Items in column 6 are census figures adjusted. Column 7 = column 6 − column 5. Figures in boldface represent net decrease for the decade.

Children under 10 years of age not tabulated.

TABLE 7A

NET EFFECTIVE IMMIGRATION OF NATIVE-BORN PERSONS INTO CALIFORNIA, COMPUTED ACCORDING TO AGE, SEX AND NATIVITY, 1910-1920

1	2		3		4	5		6		7	
Age in 1910	Population in 1910		Survivors per 100,000		Age in 1920	Survivors in 1920 from 1910 population		Population in 1920[1]		Net effective immigration 1910 to 1920[1]	
	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female
0- 4	94,092	91,182	92,080	92,994	10-14	86,639	84,794	119,110	117,504	32,471	32,710
5- 9	83,150	81,266	97,270	97,524	15-19	80,879	79,254	107,583	104,417	26,704	25,163
10-14	81,300	79,908	96,545	96,817	20-24	78,491	77,365	111,050	112,338	32,559	34,973
15-19	86,433	85,982	95,097	95,478	25-29	82,195	82,095	114,310	119,352	32,115	37,257
20-24	91,206	85,977	93,888	94,513	30-34	85,631	81,260	107,376	108,501	21,745	27,241
25-29	89,287	80,785	92,616	93 778	35-39	82,694	75,759	107,768	102,670	25,074	26,911
30-34	80,802	72,506	91,260	93,010	40-44	73,740	67,438	91,484	88,798	17,744	21,360
35-39	72,000	64,952	89,920	91,987	45-49	64,742	59,747	83,952	75,587	19,210	15,840
40-44	60,336	51,947	88,137	90,317	50-54	53,179	46,917	67,085	62,317	13,906	15,400
45-49	49,972	42,601	85,108	87,549	55-59	42,530	37,296	51,164	47,707	8,634	10,411
50-54	40,909	34,509	80,067	83,308	60-64	32,754	28,749	41,898	39,064	9,144	10,315
55-59	26,395	22,842	72,790	77,125	65-69	19,213	17,617	26,821	25,716	7,608	8,099
60-64	22,637	18,685	63,012	67,713	70-74	14,264	12,653	18,409	17,425	4,145	4,772
65-69	16,433	13,632	49,839	54,787	75-79	8,190	7,469	11,587	10,741	3,397	3,272
70-74	11,512	9,045	34,314	38,949	80-84	3,950	3,523	5,265	5,062	1,315	1,539
75-79	7,417	5,593	20,092	23,313	85-89	1,490	1,304	2,080	1,985	590	681
80-84	3,544	2,596	10,115	11,876	90-94	358	308	424	475	66	167
85-89	1,140	911	4,223	4,552	95-99	48	41	92	79	44	38
90-94	235	224	968	944	100+	3	2	14	12	11	10
95-99	50	43	0	0							
100+	9	6	0	0							
Totals	918,859	845,192				810,990	763,591	1,067,472	1,039,750	256,482	276,159
Total net effective immigration of native-born persons[1]											532,641

Sources of information and bases of estimates:

For details see discussion and footnote on page 37. Items in columns 2 are census figures adjusted. Column 3 was computed by method given in footnote on page 37. Column 5 = column 2 x column 3 ÷ 100,000. Items in column 6 are census figures. Column 7 = column 6 − column 5.

[1] Children under 10 years of age not included.

TABLE 8A

NET EFFECTIVE IMMIGRATION OF FOREIGN-BORN PERSONS INTO CALIFORNIA, COMPUTED ACCORDING TO AGE, SEX AND NATIVITY, 1910-1920

1	2		3		4	5				7	
Age in 1910	Population in 1910		Survivors per 100,000		Age in 1920	Survivors in 1920 from 1910 population		Population in 1920		Net effective immigration 1910 to 1920	
	Males	Females	Males	Females		Males	Females	Males	Females	Males	Females
0- 4	4,259	4,087	91,873	92,943	10-14	3,680	3,795	10,180	11,442	6,500	7,355
5- 9	6,343	5,992	97,094	97,491	15-19	6,160	5,816	17,440	14,849	11,280	9,033
10-14	9,388	8,675	96,317	97,006	20-24	9,290	8,669	29,991	23,524	20,701	14,855
15-19	15,088	8,201	96,252	96,062	25-29	15,289	7,880	43,478	21,120	28,189	13,240
20-24	40,208	17,202	94,728	95,928	30-34	38,450	16,504	54,560	24,489	15,450	7,985
25-29	64,240	35,992	93,571	93,809	35-39	59,898	33,694	64,372	36,408	13,394	14,794
30-34	61,001	39,218	91,511	92,946	40-44	55,873	36,594	56,102	40,093	3,488	14,899
35-39	42,944	31,854	89,072	91,076	45-49	38,102	29,092	40,702	36,823	2,600	7,731
40-44	41,067	31,927	88,179	89,505	50-54	36,236	28,566	43,066	34,562	6,830	5,996
45-49	30,776	25,298	81,287	84,348	55-59	25,018	21,335	31,776	29,017	6,758	7,682
50-54	26,242	23,326	74,307	77,545	60-64	19,495	18,078	25,134	24,708	5,639	6,630
55-59	21,178	19,666	66,684	69,519	65-69	14,124	13,677	17,877	17,683	3,753	4,006
60-64	21,472	19,886	58,109	57,660	70-74	11,302	10,974	12,308	11,919	1,006	945
65-69	13,567	9,131	43,728	45,827	75-79	5,942	4,159	7,471	5,843	1,529	1,684
70-74	8,947	6,810	30,078	32,574	80-84	2,713	2,082	4,071	3,081	658	999
75-79	5,243	5,828	18,407	16,749	85-89	899	708	1,238	1,209	292	501
80-84	2,422	1,921	9,572	10,138	90-94	232	195	328	323	96	128
85-89	906	679	4,484	4,795	95-99	40	32	81	77	41	45
90-94	258	161	1,749	2,212	100+	4	4	32	44	28	40
95-99	59	46	0	0							
100+	20	20	0	0							
Totals	409,972	308,229				425,889	270,105	605,843	468,529	134,046	158,724
Total net effective immigration of foreign-born persons											292,770

Sources of information and bases of estimates.

For details see footnotes on page 47. Items in column 2 are census figures adjusted. Column 3 was computed by method given in Footnote to page 47. Column 5—column 2 x column 3 ÷ 100,000. Items in column 6 are census figures. Column 7—column 6 - column 5.

[1] Children under 10 years of age not considered.

TABLE 9A

NET EFFECTIVE IMMIGRATION INTO CALIFORNIA, COMPUTED ACCORDING TO AGE AND SEX, 1920-1930

1	2		3		4	5		6		7	
Age in 1920	Population in 1920		Survivors per 100,000		Age in 1930	Survivors in 1930 from 1920 population		Population in 1930[1]		Net effective immigration 1920 to 1930[1]	
	Male	Female	Male	Female		Male	Female	Male	Female	Male	Female
0- 4	140,376	135,351	96,180	96,520	10-14	135,014	130,641	212,300	196,574	77,286	65,933
5- 9	141,117	138,862	96,950	97,610	15-19	136,813	135,543	196,175	174,767	59,362	39,224
10-14	130,826	128,450	95,700	96,400	20-24	125,200	123,826	233,872	200,233	108,672	76,407
15-19	124,564	118,762	94,320	94,720	25-29	117,489	112,491	294,316	236,639	176,827	124,148
20-24	140,432	134,336	93,170	93,680	30-34	130,840	125,846	326,568	263,361	195,728	137,515
25-29	157,214	150,221	92,020	93,250	35-39	144,668	140,081	244,875	217,198	100,207	77,117
30-34	163,653	142,935	90,930	93,110	40-44	148,810	133,087	223,265	192,802	74,455	59,715
35-39	171,308	138,749	89,940	92,620	45-49	154,074	128,509	232,181	178,539	78,107	50,030
40-44	143,108	119,245	88,460	91,190	50-54	126,593	108,740	197,767	156,461	71,174	47,721
45-49	130,234	101,927	85,250	88,800	55-59	111,024	90,511	122,949	118,680	11,925	28,169
50-54	107,354	87,086	80,150	85,060	60-64	86,044	74,075	91,046	91,320	5,002	17,245
55-59	82,611	66,602	73,280	79,180	65-69	60,537	52,735	66,939	70,411	6,402	17,676
60-64	66,786	54,732	64,320	70,540	70-74	42,957	38,608	42,360	44,589	**597**	5,981
65-69	44,533	37,692	52,900	58,200	75-79	23,558	21,937	32,261	33,960	8,703	12,023
70-74	30,983	26,695	38,510	42,110	80-84	11,932	11,241	10,346	11,040	**1,576**	**201**
75-79	18,989	16,550	22,440	25,000	85-89	4,261	4,137	10,053	11,024	5,792	6,887
80-84	8,605	8,038	9,270	11,260	90+	970	1,120	7,943	8,826	6,973	7,706
85-89	3,346	3,185	5,000	6,000							
90-94	750	803	2,000	3,000							
95-99	173	156									
100+	47	56									
Unknown	6,582	2,837									
Totals	1,813,591	1,613,270				1,560,784	1,433,128	2,545,226	2,206,424	684,442	773,296
Total net effective immigration into California[1]											1,757,738

Sources of information and bases of estimates:

For details see discussion and footnote on page 37. Items in column 2 are census figures. Column 3 was computed by method given in footnote on page 37. Column 5 = column 2 x column 3 ÷ 100,000. Items in column 6 are estimates of populations of given age groups based upon preliminary census returns on 1930 population and trends in the percentage age and sex distribution in California population over several decades. Column 7 = column 6 − column 5. Figures in boldface represent net decrease for the decade.

[1] Children under 10 years of age not included.

APPENDIX B

TABLE 1B

INDEX NUMBERS OF AGRICULTURAL PRODUCTION IN CALIFORNIA, 1909-1929

Base period 1909-1914 average production=100

Year	Index numbers	Year	Index numbers
1909	77	1920	112
1910	91	1921	171
1911	106	1922	145
1912	102	1923	190
1913	85	1924	158
1914	115	1925	158
1915	120	1926	181
1916	119	1927	189
1917	141	1928	205
1918	141	1929	181
1919	142		

Sources of data:

Fruits and nuts include oranges, lemons, grapefruit, grapes, olives, figs, cherries, prunes, apricots, apples, peaches, pears, almonds and walnuts. For sources of data see text or 2B to 5B inclusive.

Cereals include corn, wheat, oats, barley, rice and grain sorghums. Production for 1909-1918 from Agricultural Yearbooks, U. S. Dept. of Agr., 1909-1918; for 1919-1923 from Kaufman, E. E., California Crop Reports 1923; for 1924-1928 from Kaufman, E. E., California Crop Report 1928; for 1929 from unmimeographed sheet of California Crop Reporting Service, January 2, 1930. In the case of grain sorghums, production was estimated for the years 1910-1918, inclusive, on the basis of 1909 California production from the Thirteenth Census of the United States, and production for 1919-1929, inclusive, was taken from the above sources. This grain constitutes a small percentage of the total. Each cereal was converted into pounds and combined into one series.

Miscellaneous field crops include potatoes, beans, hay, sugar beets. Potato production for 1909-1918 from Agricultural Yearbooks, U. S. Dept. of Agr., 1909-1918; for 1919-1929 from Kaufman, E. E., California Crop Reports 1923, 1927, 1928, and unmimeographed sheet dated January 2, 1930. Bean production for 1909-1928 was taken from Wellman, H. R., and E. E. Bruce, Bean Bul. 444, California Agr. Exp. Sta., December 1927, for 1927-1928 inclusive, from Kaufman, E. E., California Crop Reports 1928, and unmimeographed sheet dated January 2, 1930. Cotton production for 1909 from the Fourteenth United States Census, Statistics for California, 1920; for 1910-1918 from Agricultural Yearbooks, U. S. Dept. of Agr., 1917 and 1920; 1919-1924 from Kaufman, E. E., California Crop Reports 1923-1928 and unmimeographed sheet dated January 2, 1930. Sugar beet production for 1909-1920 computed by multiplying area by average production per acre given in Agricultural Yearbooks, U. S. Dept. of Agr., 1909-1919. Production for 1917-1929 from Agricultural Yearbook, U. S. Dept. of Agr., 1929; for 1910-1929, inclusive, from Kaufman, E. E., California Crop Reports 1923-1928 and unmimeographed statement dated January 2, 1930.

Vegetables include asparagus, sweetpotatoes, cauliflower, celery, lettuce, peas, spinach, tomatoes and watermelons. Production for 1923-1929 based upon relative acreage in vegetables determined from Table 14 for 1924-1929 from Kaufman, E. E., California Crop Reports 1928-1929 and data not published.

Under the head livestock products for 1909-1919 was computed as follows: California per capita consumption for 1924 was computed on the basis of 1924 egg production from U. S. Census of Agriculture, 1925, minus shipments out of California. This per capita consumption, together with population figures, from the basis of California consumption 1909-1919. To this was added net shipments. Wool production for 1909-1929 was taken from Voorhies, Edwin C., Economic Aspects of the Sheep Industry, California Agr. Exp. Sta. Bul. 421, 110, 1926. Butterfat production for 1909-1914 also from Voorhies, Edwin C., Economic Aspects of the Dairy Industry, California Agr. Exp. Sta. Bul. 417, 8, 1927. Production for 1915-1929 is from McDonald, M. A., Statistical Digest of California Dairy Production 1928 and unpublished report of 1929.

Meat production includes kill statistics of California slaughter of pork, lamb and mutton, veal and veal produced in California for stock subsistence and estimates (net) pertaining of weight gained by animals before shipment into California. See Tables 6B to 8B, inclusive.

Method of calculation:

Four production in pounds as given in Table 1A were converted to relatives on the basis of the 1909-1929 average production. Next each set of cereals and vegetables was combined on a similar manner. Cereals, likewise, were converted to pounds and the whole group to a relative index on the same base period. In the case of livestock products separate index of relatives were prepared for eggs, wool, butterfat and all classes combined. For vegetables production statistics being available only for the years 1924-1929, inclusive, two series of relatives were prepared on the same base period as for the other commodities, one for acreage and the other for production, and the relative acreage for 1923 and 1929 was used in lieu of relatives of production. A separate relative index was computed for each of the cereal-grain field crops. Two series of index numbers were constructed, one for the years 1910-1919, based upon 10 commodities, the other from 1909-1929, based upon 20 commodities. Each of these series was computed by constructing a weighted geometric mean for each of the relatives mentioned above. Weights used were the average values of the groups in the five year period 1909-1929, inclusive. The upper series of the two is designed to show yearly production. Only wool and butterfat are represented from this group. Vegetables are not included in the weight system. In the average series, however, vegetables (acreage of California producing five crops previously mentioned) are included in detail in other sections of this report. The two series were combined into one index by using the more complete series from 1909-1919 and the less complete series from 1909-1929, inclusive. The previous index was converted to the base period, 1910-1914, by dividing by the average of the index numbers for the five year period.

TABLE 2B

ACREAGES AND TRENDS IN THE ACREAGES OF NON-BEARING FRUIT IN THE SAN JOAQUIN VALLEY, 1919-1929

Year	Non-bearing acreage				Total non-bearing acreage	
	Sub tropical fruits		Temperate zone fruits			
	Acreage	Trend	Acreage	Trend	Acreage	Trend
1919	76,818	74,900	17,211	17,130	94,029	92,030
1920		84,543		19,420		103,963
1921		98,380		21,790		120,170
1922		107,865		24,152		132,017
1923		111,358		26,565		137,923
1924	131,158	100,800	28,908	31,250	160,066	132,050
1925	76,724	78,636	39,295	33,692	116,019	112,328
1926	42,033	51,056	39,478	31,800	81,511	82,856
1927	27,723	29,831	23,607	26,047	51,330	55,878
1928	18,211	19,228	15,023	19,240	33,234	38,468
1929	14,350	15,327	14,985	15,440	29,335	30,767

Sources of data:

Yearly Crop Reports of the California Crop Reporting Service.

TABLE 3B

ACREAGES AND TREND OF THE TOTAL ACREAGE OF THE NON-BEARING SUB-TROPICAL AND TEMPERATE ZONE FRUITS IN CALIFORNIA, 1919-1929

Year	Sub-tropical fruits acreage	Temperate fruits acreage	Total	
			Acreage	Trend
1909	152,102	89,408	241,510	240,900
1910				243,700
1911				246,650
1912				249,800
1913				253,200
1914				257,500
1915				262,050
1916				268,300
1917				276,200
1918				286,150
1919	169,287	123,189	292,476	297,600
1920				314,800
1921				337,700
1922				365,000
1923				389,050
1924	254,162	151,464	405,626	406,900
1925	203,508	206,622	410,130	405,500
1926	148,719	177,720	326,439	328,300
1927	138,796	145,668	284,464	277,500
1928	124,985	110,249	235,234	234,600
1929	111,974	82,168	194,142	194,200

Sources of data:

1924-1929, California Co-operative Crop Reporting Service, California Crop Reports: 1909-1919, Fourteenth Census of the United States, Statistics for California, 1920-71. (Numbers of trees and vines were converted to acres.)

TABLE 48

ACREAGES AND TRENDS IN THE ACREAGES OF THE BEARING SUB-TROPICAL FRUITS IN CALIFORNIA, 1909-1929

In thousands of acres

Year	Lemons		Oranges		Grapefruit		Walnuts		Almonds		Grapes		Olives		Figs		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	13	13	74	72	0.8	2	24	24	20	20	944	916	34	34	5	5	400.5	418
1910		13		73		3		24		20		925		34		5		473
1911		13		74		4		25		19		934		34		5		483.4
1912		14		75		5		26		18		943		34		5		489.4
1913		14		76		6		27		17		950		34		5		497.2
1914	13	13	95	100	1.0	7	24	28	18	17		919	32	33	6	5	514	511.2
1915	10	10	116	103	1.0	8	24	29	19	19		918	33	33	6	6	507	524
1916	22	22	117	116	1.8	10	33	30	20	23		915	32	32	6	6	503	550
1917	23	24	124	127	2.0	13	45	44	28	28		919	28	28	6	6	563	577
1918	27	28	133	131	2.0	15	45	47	30	30		929	32	30	6	6	595	597
1919	30	29	146	140	2.0	16	51	52	30	32	235	937	29	29	11	11	557	650
1920	44	39	150	147	3.0	17	56	56	35	35	249	944	30	30	11	11	718	720
1921	43	43	173	160	4.0	18	62	60	41	42	303	922	34	30	15	14	745	747
1922	42	42	174	170	4.0	19	63	63	41	46	447	419	24	24	13	13	824	776
1923	42	42	177	177	4.0	20	67	67	57	50	483	482	27	27	17	17	832	832
1924	43	43	178	178	4.0	20	68	70	61	55	517	519	27	27	21	21	870	870
1925	44	44	181	181	4.0	20	70	73	68	59	536	540	27	27	25	25	1,000	1,000
1926	44	44	184	184	5.0	22	75	76	74	64	546	560	27	27	30	30	1,062	1,064
1927	44	44	186	186	5.0	23	78	78	85	82	603	582	28	28	33	33	1,126	1,111
1928	43	43	187	187	5.0	23	82	82	88	88	564	602	29	29	42	42	1,138	1,151
1929	43	43	191	190	9.0	9.0	88	88	92	92	640	635	29	29	47	47	1,139	1,151

Source of data:

Lemons, oranges, grapefruit, grapes, olives and figs for 1909, Dept. of Com., Bur. of Census, Fourteenth Census of the U. S., 1920, 969, 972, 973. Walnuts and almond acreages for 1909 were estimated by dividing the 1910 production by the average production per acre for the years 1924-1929, 1914-1919, California Co-operative Crop Reporting Service, California Crop Report, 1927, 38. 1910-1929, California Co-operative Crop Reporting Service, California Crop Report, 1928 45

TABLE 5B

ACREAGES AND TRENDS IN THE ACREAGES OF THE BEARING TEMPERATE ZONE FRUITS IN CALIFORNIA, 1909-1929

In thousands of acres

Year	Cherries		Pears		Apricots		Apples		Peaches		Prunes and plums		Totals	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	5	5	14	14	37	38	35	35	79	62	72	66	242	220
1910	----------	6	----------	14	----------	37	----------	35	----------	78	----------	71	----------	241
1911	----------	7	----------	14	----------	36	----------	36	----------	93	----------	77	----------	263
1912	----------	7	----------	15	----------	36	----------	37	----------	104	----------	84	----------	283
1913	----------	8	----------	16	----------	36	----------	38	----------	112	----------	90	----------	300
1914	8	8	16	17	34	36	38	38	116	115	99	98	311	312
1915	8	8	18	18	41	38	39	39	114	114	108	107	328	324
1916	8	8	18	19	40	40	40	40	114	113	119	114	339	334
1917	8	8	20	20	40	41	42	41	114	110	120	118	344	338
1918	9	9	22	22	41	42	44	43	107	108	120	120	343	344
1919	9	9	23	24	46	46	47	45	103	104	121	121	349	349
1920	9	9	29	28	48	49	47	46	103	102	123	123	359	357
1921	9	9	31	32	56	54	50	48	101	104	126	128	373	375
1922	9	9	38	35	61	59	52	50	106	106	134	134	400	393
1923	10	10	41	39	62	62	53	52	109	109	143	143	418	415
1924	10	10	43	43	64	65	54	53	112	113	154	154	437	438
1925	10	10	47	47	67	68	55	54	119	120	168	167	466	466
1926	11	11	52	51	72	72	56	55	126	128	187	182	504	499
1927	12	11	56	56	75	76	57	56	142	140	199	195	541	534
1928	12	12	62	62	80	79	57	57	154	142	208	205	573	557
1929	13	13	69	69	82	82	57	57	137	136	212	212	570	569

Sources of data:

1909, Dept. of Com., Bur. of Census, Census of the U. S., Statistics for California, 1920: 863-869. Cherries and apricots for 1914-1918, California Co-operative Crop Reporting Service, California Crop Report, 1927: 39; 1919-1929, California Co-operative Crop Reporting Service, California Crop Report, 1928: 45. Pears, apples, peaches, prunes and plums for 1914-1928, California Co-operative Crop Reporting Service, California Crop Report, 1927: 39; 1929, California Co-operative Crop Reporting Service, California Crop Report, 1928: 45.

TABLE 5B

ACREAGES AND TRENDS IN THE ACREAGES OF VEGETABLES IN CALIFORNIA, 1909-1929

In thousands of acres

Year	Celery		Onions		Cantaloupes		Cauliflower		Lettuce		Peas		White potatoes	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909														
1910														
1911														
1912														
1913														
1914														
1915														
1916														
1917														
1918														
1919	9	4	8	9	25	25			15	10	6	6	85	77
1920	8	5	12	10	28	28			15	14	8	10	85	85
1921	8	6	10	10	30	30			15	17	10	11	85	93
1922	8	6	10	10	30	30			15	21	13	12	85	101
1923	8	6	8	8	34	33			18	25	14	13	85	109
1924	8	6	6	8	40	36			18	28	11	14	85	117
1925	8	6	6	6	38	39			18	30	11	15	85	125
1926	8	7	6	5	40	42			18	31	10	16	85	133
1927	8	7	6	5	44	42	10		18	31	10	16	85	141
1928	8	8	8	6	45	45	9	11	22	32	12	16	85	149
1929	8	9	10	10	44	46	13	12	32	34	16	16	85	157
1930	9	9	12	13	50	48	14	12	37	34	16	16	85	165

TABLE 6B—Continued

ACREAGES AND TRENDS IN THE ACREAGES OF VEGETABLES IN CALIFORNIA, 1909-1929

In thousands of acres

Year	Asparagus		Sweet potatoes		Tomatoes		Spinach		Watermelons		All others		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909													152	152
1910														160
1911														170
1912														180
1913														190
1914														200
1915														210
1916														220
1917														230
1918														240
1919	17	17	8	8	54	36	4	4	6	6	31	31	249	242
1920	20	19	8	8	40	34	4	4	6	7	33	33	260	249
1921	21	21	8	8	14	31	6	6	9	8	35	36	237	258
1922	22	22	8	8	31	31	7	7	10	9	38	38	284	268
1923	28	28	6	7	44	35	10	8	8	10	38	39	280	281
1924	30	33	6	8	38	39	7	9	12	10	39	41	286	298
1925	41	40	9	9	42	43	12	10	10	11	45	44	320	331
1926	56	48	12	11	45	46	12	12	13	12	45	45	382	368
1927	58	56	12	12	52	48	12	13	10	12	48	47	421	406
1928	60	59	12	12	48	51	13	14	12	12	49	49	425	436
1929	60	60	12	12	53	52	17	16	14	12	57	53	471	460

Sources of data:

Potatoes and sweet potatoes, 1919-1921, California Co-operative Crop Reporting Service, California Crop Report 1925: 8-9; 1922, California Co-operative Crop Reporting Service, California Crop Report 1926: 7-8; 1923, California Co-operative Crop Reporting Service, California Crop Report, 1927: 8; 1924-1928, California Co-operative Crop Reporting Service, California Crop Report 1928: 10: 1929, California Co-operative Crop Reporting Service, Summary of California Annual Field Crop Report, Nov. 13, 1929.

Vegetables, other than potatoes, 1919, California Co-operative Crop Reporting Service, California Crop Report 1923:14; 1920, California Co-operative Crop Reporting Service, California Crop Report, 1924: 19; 1921-1923, California Co-operative Crop Reporting Service, California Crop Report 1925: 29; 1924, California Co-operative Crop Reporting Service, California Crop Report, 1926: 13-14: 1925–1927, California Co-operative Crop Reporting Service, California Crop Report, 1928: 20-22; 1928-1929, California Co-operative Crop Reporting Service, mimeographed report of Jan. 2, 1930; 1909, Dept. of Com., Bur. of Census, Thirteenth Census of the U. S., Statistics for California 1910: 650. (Potatoes and sweet potatoes and yams were added to "all other vegetables.")

TABLE 78

ACREAGES AND TRENDS IN THE ACREAGES OF MISCELLANEOUS FIELD CROPS, INCLUDING SUGAR BEETS, COTTON AND BEANS, HARVESTED IN CALIFORNIA: 1909-1929

In thousands of acres

Year	Sugar beets		Cotton		Beans		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	[illegible]	83			259	225	583	591
1910	80	88	6	8	240	260	592	642
1911	99	108	12	18	322	304	641	774
1912	113	127	9	23	229	295	545	881
1913	128	133	14	24	187	290	549	489
1914	104	138	42	36	344	269	491	942
1915	123	134	10	35	468	424	601	1.0
1916	120	141	62	50	472	480	654	712
1917	136	143	130	125	580	623	918	786
1918	140	150	181	171	562	542	863	869
1919	157	152	158	166	472	440	744	791
1920	127	161	273	230	408	368	808	685
1921	151	167	140	206	272	289	562	627
1922	137	171	262	260	324	290	682	567
1923	153	175	206	166	281	268	640	537
1924	84	178	159	174	258	264	416	602
1925	79	182	170	191	240	290	488	685
1926	49	186	152	196	260	279	511	561
1927	54	84	178	170	260	293	483	597
1928	43	50	218	190	307	315	574	546
1929	48	48	300	214	304	328	691	600

Sources of data:

Sugar beets, 1909-1918 Yearbooks of the U. S. Dept. of Agr., 1919-1929, California Co-operative Crop Reporting Service, California Crop Reports 1914-1941; 1924-1927, California Co-operative Crop Reporting Service, California Crop Report 1928-36; 1928-1929, California Co-operative Crop Reporting Service, Summary of California Annual Field Crop Reports, January 2, 1930.

Cotton, 1909-1918, Yearbooks of the U. S. Dept. of Agr. 1919-1929, 1930-1933, California Co-operative Crop Reporting Service, California Crop Report 1914-36-38; 1924-1927, California Co-operative Crop Reporting Service, California Crop Report 1928, 1-30.

Beans, 1909-1917, estimated on basis of average yield per acre for the years 1918-1929, yielded per total production for the years 1909-1917. 1918, Yearbook of the U. S. Dept. of Agr. 1919-1929, 1930-1933, California Co-operative Crop Reporting Service, California Crop Report 1924, 19-41; 1924-1927, California Co-operative Crop Reporting Service California Crop Report 1928-36; 1928-1929, California Co-operative Crop Reporting Service, Summary of California Annual Field Crop Report, January 2, 1930.

TABLE 8B

ACREAGES AND TREND OF THE TOTAL ACREAGE OF HAY CROPS HARVESTED IN CALIFORNIA, 1909-1929

In thousands of acres

Year	Alfalfa acreage	Grain hay acreage	Other tame hay acreage	Wild hay acreage	Total	
					Acreage	Trend
1909	484	1,605	161	253	2,503	2,492
1910						2,411
1911						2,415
1912						2,376
1913						2,345
1914						2,308
1915						2,274
1916						2,238
1917						2,205
1918						2,160
1919	719	1,085	156	178	2,138	2,161
1920						2,148
1921						2,155
1922						2,155
1923						2,122
1924	964	892	118	114	2,088	2,075
1925	971	694	112	148	1,925	1,975
1926	981	616	102	150	1,849	1,904
1927	1,001	546	102	147	1,796	1,850
1928	1,011	546	97	150	1,804	1,893
1929	991	759	102	150	2,002	1,948

Sources of data:

1909, 1919, Dept. of Com., Bur. of Census, Fourteenth Census of the United States 1920: 807; 1924, California Crop Report 1926: 9; 1925, California Crop Report 1927: 9; 1926, 1927, 1928, California Crop Report 1928: 12; 1929, California Co-operative Crop Reporting Service, California Crop Report, August 1, 1929.

TABLE 9B

ACREAGES AND TREND OF THE TOTAL ACREAGE OF THE CEREAL CROPS HARVESTED IN CALIFORNIA, 1909-1929

In thousands of acres

Year	Rice acreage	Corn acreage	Sorghum grains acreage	Wheat acreage	Barley acreage	Oats acreage	Total	
							Acreage	Trend
1909		50	44	426	1,195	200	1,915	2,281
1910		50		550	1,500	200		2,238
1911		51		480	1,450	210		2,221
1912	2	52		370	1,392	200		2,218
1913	6	55		300	1,275	210		2,213
1914	15	60		400	1,402	220		2,222
1915	34	64		440	1,360	211		2,214
1916	55	64		350	1,190	200		2,210
1917	80	75		375	1,350	196		2,226
1918	106	85		506	1,320	175		2,235
1919	155	149	168	1,087	987	147	2,693	2,230
1920	162	139	150	714	1,250	155	2,570	2,215
1921	135	116	140	557	1,188	140	2,276	2,197
1922	140	116	130	712	1,129	150	2,377	2,176
1923	106	128	135	748	1,095	162	2,374	2,157
1924	90	82	84	377	698	86	1,417	2,140
1925	103	81	88	603	1,040	151	2,066	2,132
1926	149	77	96	653	1,080	156	2,211	2,115
1927	160	77	130	812	994	147	2,320	2,125
1928	132	75	125	780	1,044	154	2,310	2,123
1929	95	82	115	680	992	145	2,109	2,131

Sources of data:

Rice, corn, sorghum grains and oats for 1909-1918, Yearbook of the U. S. Dept. of Agr. for the various years; 1919-1923, California Co-operative Crop Reporting Service, California Crop Report 1924: 10-11; 1924-1927, California Co-operative Crop Reporting Service, California Crop Report 1928: 9-10; 1928, 1929, California Co-operative Crop Reporting Service, Summary of California Annual Field Crop Report, January 2, 1930

Wheat and barley for 1909-1925, California Co-operative Crop Reporting Service, California Crop Report 1925: 11; 1926, 1927, California Co-operative Crop Reporting Service, California Crop Report 1927: 7; 1928, 1929, California Co-operative Crop Reporting Service, Summary of California Annual Field Crop Report, January 2, 1930.

TABLE 16B

ACREAGES AND TRENDS IN THE ACREAGES OF ALL LAND IN FARMS IN THE SAN JOAQUIN VALLEY, 1909-1929

Years	Crop land harvested		Nonbearing orchard		Other improved land		Woodland in farms		Other land in farms		Total land in farms	
	Acreage	Trend	Acreage	Trend	Acreage	Trend[1]	Acreage	Trend[1]	Acreage	Trend[1]	Acreage	Trend
1909	1,439,000	1,493,000			2,065,274	2,084,190	641,865	641,865	2,772,461	2,142,135	7,100,290	7,351,690
1910		1,613,700				2,027,930		638,502		2,186,158		7,208,302
1911		1,678,500				2,004,425		635,859		2,188,141		7,406,125
1912		1,684,700				1,946,775		632,586		2,217,164		7,481,475
1913		1,707,800				1,907,200		629,850		2,230,147		7,437,800
1914		1,723,200				1,885,535		626,850		2,248,150		7,423,935
1915		1,752,000				1,778,010		623,847		2,250,153		7,368,010
1916		1,792,400				1,718,250		620,844		2,259,132		7,390,626
1917		1,852,500				1,624,215		617,841		2,247,159		7,341,615
1918		1,884,200				1,592,145		614,838		2,263,162		7,354,345
1919	2,058,334	1,948,900	94,939	92,030	1,541,804	1,507,985	606,332	611,835	3,217,866	2,288,153	7,520,040	7,388,915
1920		1,997,600		108,960		1,263,084		608,832		2,691,158		7,269,047
1921		2,063,700		128,170		1,171,095		605,829		2,539,171		7,208,965
1922		2,104,800		142,017		1,109,571		602,826		2,547,174		7,206,661
1923		2,047,500		147,950		1,070,307		599,823		2,560,177		7,225,760
1924	1,724,418	1,973,700	146,086	173,090	1,515,019	983,250	596,820	596,820	3,007,297	2,588,180	8,944,118	7,181,860
1925	2,167,500	2,138,400	110,015	112,328		929,000		572,000		2,980,000		7,123,728
1926	2,184,045	2,204,100	81,511	82,868		845,000		572,000		3,000,000		7,103,968
1927	2,350,450	2,275,100	51,550	55,878		770,000		556,000		2,419,000		7,075,978
1928	2,492,984	2,336,200	33,224	35,488		715,000		559,000		2,402,000		7,092,688
1929	2,370,500	2,384,200	26,333	30,747		677,000		549,000		2,472,000		7,112,947

[1] For the years 1925-1929, average figures were not available, but the trend in acreage was extended over these years.

Sources of data:

Figures for irrigated land harvested and for nonbearing orchard were obtained from Tables 28 and 30. Other improved land, woodland in farms, and other land in farms for the years 1909, 1919 and 1925 were obtained from Dept. of Com., Bur. of Census, Census of the U. S., Statistics for California, 1910, 1920 and 1925.

TABLE 11B

ACREAGES AND TRENDS IN THE ACREAGES OF THE BEARING SUB-TROPICAL FRUITS IN THE SAN JOAQUIN VALLEY, 1909-1929

Years	Lemons		Oranges		Grapefruit		Walnuts		Almonds		Grapes		Olives		Figs		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	679	675	10,913	10,700	517	510	352	350	2,747	2,700	160,246	160,000	2,154	2,100	4,841	4,750	182,449	181,785
1910		760		11,000		555		450		3,500		165,000		2,550		5,500		189,315
1911		850		13,500		600		550		4,250		170,000		3,000		6,500		199,250
1912		950		15,000		650		650		5,000		177,500		3,450		7,500		210,700
1913		1,035		16,500		690		750		5,800		182,500		3,900		8,750		219,925
1914		1,125		17,800		740		850		6,575		189,000		4,400		9,750		230,240
1915		1,225		19,250		790		975		7,300		195,000		4,825		10,750		240,115
1916		1,325		20,800		830		1,100		8,100		202,500		5,300		12,000		251,955
1917		1,425		22,250		885		1,200		8,900		209,000		5,750		13,000		262,410
1918		1,575		23,750		930		1,300		9,650		217,500		6,200		14,000		274,905
1919	1,605	1,730	25,131	26,000		980	1,434	1,625		10,400	223,385	235,000		6,700		15,250	284,885	297,685
1920		1,900		28,450		1,028		2,200		11,200		257,500		7,125		16,500		325,903
1921		2,175		31,150		1,070		2,850		12,000		285,000		7,600		17,500		359,345
1922		2,415		33,750		1,120		3,575		12,775		320,000		8,050		18,500		400,185
1923		2,630		36,500		1,170		4,350		13,400		361,500		8,500		20,000		448,050
1924	2,914	2,825	39,231	39,000	1,215	1,195	5,058	5,000	14,325	14,000	369,888	407,300	9,158	9,100	20,880	22,500	462,669	500,920
1925	3,015	2,925	40,193	40,250	1,209	1,210	5,624	5,500	14,231	14,700	460,495	440,000	9,617	9,125	23,538	26,500	557,922	540,210
1926	2,970	2,975	42,192	41,500	1,209	1,210	5,883	6,050	15,136	15,500	488,353	466,000	9,766	8,900	31,897	34,000	597,406	576,135
1927	2,997	2,990	42,380	42,000	1,211	1,210	6,206	6,800	16,861	16,000	493,493	480,000	7,538	8,800	41,259	40,500	611,945	598,300
1928	2,994	3,000	42,583	42,500	1,203	1,210	8,159	7,700	17,203	15,800	483,659	475,000	7,945	9,500	58,217	45,000	621,963	599,710
1929	2,964	3,000	42,497	42,450	1,215	1,200	8,661	8,500	14,841	15,200	467,429	461,500	11,667	11,600	43,163	46,250	592,437	589,700

Sources of data:

1909, Dept. of Com., Bur. of Census, Thirteenth Census of the U. S., Statistics for California, 1910: 650-655; 1919-1929, Yearly Crop Reports of the California Co-operative Crop Reporting Service.

TABLE 12B

ACREAGES AND TREND OF THE TOTAL ACREAGE OF THE BEARING TEMPERATE ZONE FRUITS IN THE SAN JOAQUIN VALLEY, 1909-1929

Year	Olives acreage	Plum acreage	Almond acreage	Apricot acreage	Peach acreage	Prune and plum acreage	Total	
							Acreage	Trend
1909	248	892	9,084	1,597	41,294	8,242	57,792	57,400
1910								58,400
1911								59,400
1912								60,800
1913								62,100
1914								63,200
1915								64,300
1916								65,700
1917								67,100
1918								68,800
1919	245	1,279	8,287	4,468	49,201	7,452	69,369	73,200
1920								78,100
1921								84,160
1922								91,200
1923								99,500
1924	275	2,502	12,867	3,692	62,214	24,820	106,490	107,200
1925	290	3,117	14,019	4,441	67,094	28,433	118,474	114,500
1926	310	3,394	15,035	4,895	69,869	30,489	121,589	120,400
1927	330	3,771	16,743	5,712	81,166	25,165	132,887	124,000
1928	300	3,458	21,498	5,947	74,891	24,327	130,231	125,300
1929	250	3,498	18,827	5,892	66,089	28,255	113,092	125,200

Sources of data:

1909, Dept. of Com., Bur. of Census, Thirteenth Census of the U. S., Statistics for California, 1910: 650-655; 1919, Dept. of Com., Bur. of Census, Fourteenth Census of the U. S., Statistics for California, 1920: 87-92, 1924-1929, Yearly Crop Reports of the California Co-operative Crop Reporting Service.

TABLE 13B

ACREAGES AND TREND OF THE TOTAL ACREAGE OF THE MAJOR GROUPS OF VEGETABLES HARVESTED IN THE SAN JOAQUIN VALLEY, 1909-1929

Year	Potatoes acreage	Sweet potatoes acreage	Truck crops acreage	Total	
				Acreage	Trend
1909	22,500	3,000	16,158	41,292	42,874
1910					45,750
1911					48,750
1912					51,425
1913					54,100
1914					56,600
1915					58,925
1916					60,750
1917					62,750
1918					64,100
1919	24,000	4,000	26,364	54,364	64,400
1920	25,000	5,200			65,150
1921	32,000	5,400			65,600
1922	30,000	6,800			64,875
1923	22,000	4,900			64,050
1924	24,000	4,400			64,750
1925	21,000	7,700			66,700
1926	27,000	10,000	17,000	54,000	65,300
1927	32,000	8,200	14,000	54,800	64,500
1928	30,000	8,000	14,000	52,000	63,725
1929	16,000	8,000	28,700	52,000	67,000

Sources of data

1909, Dept. of Com., Bur. of Census, Thirteenth Census of the U. S., Statistics for California, 1910: 650-655; 1919-1929, Yearly Crop Reports of the California Co-operative Crop Reporting Service.

TABLE 14B

ACREAGES AND TRENDS IN THE ACREAGES IN THE MISCELLANEOUS FIELD CROPS, INCLUDING SUGAR BEETS, BEANS AND COTTON, HARVESTED IN THE SAN JOAQUIN VALLEY, 1909-1929

Years	Sugar beets		Beans		Cotton		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	2,105	2,105	14,942	14,942			17,047	17,047
1910		2,175		18,000				20,175
1911		2,250		21,500				23,750
1912		2,325		24,750				27,075
1913		2,400		28,000				30,400
1914		2,500		31,400				33,900
1915		2,600		34,750				37,350
1916		2,700		38,000				40,700
1917		2,800		41,250				44,050
1918		2,900		42,000				44,900
1919	3,000	2,850	48,000	40,000	5,500	11,000	56,500	53,850
1920		2,700	28,000	36,000	21,000	10,000		48,700
1921		2,500	29,000	36,000	3,500	10,000		48,500
1922		2,300	40,000	39,000	2,500	12,000		53,300
1923		2,200	51,000	45,500	9,000	25,000		72,700
1924	1,800	2,500	41,000	55,750	37,800	50,000	80,600	108,250
1925		3,000	69,000	62,000	96,600	76,500		141,500
1926		3,650	76,000	66,000	109,300	98,000		167,650
1927		4,300	64,000	66,000	79,800	122,000		192,300
1928		5,090	61,000	65,900	151,900	148,000		218,990
1929	8,000	5,900	61,000	65,750	250,000	174,000	319,000	245,650

Sources of data:

1909, Dept. of Com., Bur. of Census, Thirteenth Census of the U. S., Statistics for California, 1910: 650-655; 1919-1929, Yearly Crop Reports of the California Co-operative Crop Reporting Service.

TABLE 15B

ACREAGES AND TRENDS IN THE ACREAGES OF HAY CROPS HARVESTED IN THE SAN JOAQUIN VALLEY, 1909-1929

Year	Alfalfa		Grain hay		Other tame hay		Wild hay		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	224,189	209,000	260,417	305,447	12,247	12,247	39,492	38,453	536,345	586,196
1910		200,000		254,000		12,000		36,500		502,500
1911		200,000		245,000		11,625		35,400		492,025
1912		200,000		241,500		11,500		34,700		477,700
1913		221,000		225,000		10,500		27,000		483,500
1914		240,000		215,000		10,000		25,000		490,000
1915		254,000		205,000		10,250		22,000		491,250
1916		254,000		186,500		9,900		18,950		469,350
1917		446,000		180,000		9,500		15,000		517,000
1918		425,000		170,000		8,250		11,750		524,000
1919	417,000	440,000	190,000	190,000	8,000	8,125	10,000	11,000	625,000	656,125
1920	450,000	452,500	180,000	160,000	9,000	9,100	10,500	10,750	649,500	632,350
1921	456,000	455,000	153,000	152,000	9,250	8,600	10,000	9,800	628,250	625,400
1922	458,000	460,000	148,000	146,000	8,500	9,000	10,000	9,000	624,500	624,000
1923	480,000	482,500	160,000	155,000	7,800	8,400	8,000	7,500	655,800	653,400
1924	447,000	450,000	151,000	129,000	11,000	8,900	2,400	5,000	591,400	592,900
1925	453,000	450,000	117,000	114,000	11,500	9,475	6,500	8,000	588,000	581,475
1926	448,000	455,000	94,000	100,000	7,500	8,000	3,750	8,000	553,500	571,000
1927	450,000	457,500	87,000	103,000	7,400	7,900	8,500	8,000	581,900	575,400
1928	458,000	458,000	84,000	114,000	7,500	7,700	7,400	8,250	565,400	587,950
1929	440,000	440,000	171,000	139,000	8,500	7,600	7,400	7,250	627,900	586,850

Sources of data

1909, Teigs, *U Cons.*, Bur. Soils Circ. Thirteenth Census of the U. S., Statistics for California, 1910, 650-653, 1919-1929, Yearly Crop Reports of the California Cooperative Crop Reporting Service.

TABLE 16B

ACREAGES AND TRENDS IN THE ACREAGES OF THE CEREAL CROP HARVESTED IN THE SAN JOAQUIN VALLEY, 1909-1929

Year	Corn		Sorghums		Wheat		Barley		Oats		Rice		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	11,976	11,976	29,385	29,385	192,725	248,000	452,489	452,489	95,129	95,129			781,704	836,979
1910		16,000		33,500		215,000		445,000		90,000				799,500
1911		20,500		37,750		192,500		439,000		84,500				744,250
1912		25,000		42,250		179,000		433,000		79,000				758,250
1913		29,250		46,500		172,500		427,000		73,500				748,750
1914		33,750		50,750		174,000		422,500		68,000				749,000
1915		38,000		55,250		180,000		419,000		62,500				754,750
1916		42,000		59,500		191,000		415,000		57,000				764,500
1917		47,000		64,000		206,000		410,000		51,750				778,750
1918		50,500		67,500		226,000		415,000		47,500				806,500
1919	55,500	50,500	72,500	69,000	407,000	243,000	399,000	420,000	41,000	44,000	6,000	5,550	981,000	832,050
1920	52,000	47,000	68,500	68,500	261,000	253,000	465,000	430,000	45,000	43,500	6,000	4,700	903,500	846,700
1921	37,000	40,250	66,500	67,500	175,000	255,000	427,000	427,000	41,000	44,000	2,300	3,250	748,800	837,000
1922	30,000	36,250	63,000	63,500	297,000	255,000	422,000	400,000	46,000	44,500	1,600	1,800	859,600	801,050
1923	37,000	32,250	69,000	57,500	328,000	247,000	399,000	367,500	50,000	44,750	1,300	1,100	884,300	750,100
1924	36,000	34,250	40,000	49,500	127,000	240,000	233,000	330,000	34,000	44,000	100	900	470,100	698,650
1925	33,000	33,000	42,000	47,000	230,000	242,500	357,000	325,000	52,000	45,000	300	2,450	714,300	694,950
1926	30,000	31,000	43,000	49,500	217,000	250,000	330,000	320,000	46,000	45,500	3,100	5,900	669,100	701,900
1927	30,000	30,500	64,000	52,500	333,000	262,500	307,000	320,000	44,000	46,000	13,000	9,500	791,000	721,000
1928	28,000	30,750	62,000	55,250	315,000	280,000	332,000	319,000	48,000	45,500	13,300	11,950	798,300	742,450
1929	33,000	31,000	44,000	58,000	250,000	300,000	283,000	312,500	42,000	45,000	13,000	13,300	665,000	759,800

Sources of data:

1909, Dept. of Com., Bur. of Census, Thirteenth Census of the U. S., Statistics for California, 1910: 650-655; 1919-1929, Yearly Crop Reports of the California Co-operative Crop Reporting Service.

TABLE 17B

ACREAGES AND TRENDS IN THE ACREAGES OF THE BEARING SUB-TROPICAL FRUITS IN THE SACRAMENTO VALLEY, 1909-1929

Year	Lemons		Oranges		Grapefruit		Walnuts		Avocados		Guavas		Olives		Figs		Dates	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	83	83	1,441	1,442	10	10	471	471	8,364	8,364	10,812	10,812	2,581	2,581	319	321	48,891	48,891
1910		76		1,442		10		535		9,899		12,686		2,790		1,690		49,927
1911		173		1,442		10		600		10,900		12,450		3,125		1,130		50,292
1912		300		1,442		10		750		11,900		11,900		3,500		1,175		51,585
1913		373		1,450		10		840		12,900		11,300		3,900		1,250		52,926
1914		338		1,450		10		900		13,900		10,750		4,078		1,045		53,950
1915		400		1,460		10		1,000		14,750		10,100		4,400		1,400		54,329
1916		450		1,473		11		1,100		15,700		10,850		5,200		1,300		55,300
1917		400		1,300		11		1,200		16,700		28,950		5,925		1,500		57,000
1918		500		1,350		11		1,300		17,700		28,900		6,000		1,700		58,445
1919	640	640	1,500	1,500	12	12	1,400	1,350		18,700	27,841	28,800		6,450		1,775		60,250
1920		700		1,480		60		1,500		19,700		26,500		6,875		1,850		62,700
1921		738		1,500		60		1,200		20,700		27,000		7,300		1,925		64,610
1922		750		1,600		75		1,200		21,700		21,550		7,750		2,000		66,750
1923		860		1,680		75		1,200		22,000		23,000		8,100		2,100		72,850
1924	840	840	4,440	4,155	74	75	1,120	1,300	23,784	24,300	34,653	34,300	8,568	8,350	3,202	3,156	73,156	76,047
1925	844	844	4,240	4,100	75	75	1,455	1,400	25,888	27,450	37,772	35,800	8,468	8,050	3,121	3,250	83,865	81,316
1926	872	872	3,815	3,860	95	95	1,472	1,482	32,549	30,800	38,460	38,950	9,017	8,900	3,144	3,256	88,886	85,505
1927	868	868	3,907	3,956	90	90	1,950	1,850	33,930	33,800	38,132	39,200	9,199	9,500	3,402	3,268	93,150	91,417
1928	843	843	3,939	3,950	80	80	2,130	2,075	33,182	35,182	40,535	40,100	10,861	9,975	3,445	3,440	98,727	94,241
1929	845	845	3,866	3,866	86	86	2,232	2,300	35,865	35,865	41,874	40,650	10,244	10,400	3,587	3,587	97,309	96,953

Sources of data:

1909, 1919, *U. S. Bur. of Census*, Census of the U. S. Statistics for California, 1910: 650-655, Table 4, 1919-1929, data furnished by office of Agricultural Statistician, California Co-operative Crop Reporting Service.

TABLE 18B

ACREAGES AND TRENDS IN THE ACREAGES OF THE BEARING TEMPERATE ZONE FRUITS IN THE SACRAMENTO VALLEY, 1909-1929

Year	Cherries		Pears		Apricots		Apples		Peaches		Plums and prunes		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	826	826	4,774	4,774	6,199	6,199	1,242	1,242	12,404	12,404	11,397	11,397	36,842	36,842
1910		900		4,800		5,950		1,250		12,550		11,950		37,400
1911		1,000		5,000		5,800		1,250		12,650		12,300		38,000
1912		1,050		5,200		5,600		1,275		12,800		12,800		38,725
1913		1,100		5,400		5,450		1,300		12,950		13,300		39,500
1914		1,200		5,600		5,300		1,350		13,050		13,900		40,400
1915		1,250		5,800		5,100		1,400		13,200		14,400		41,150
1916		1,400		6,000		5,000		1,450		13,400		14,950		42,200
1917		1,450		6,200		4,800		1,475		13,500		15,600		43,025
1918		1,550		6,600		4,600		1,500		13,800		16,400		44,450
1919		1,600	6,640	7,200	4,458	4,700	1,573	1,573	13,832	14,300	16,644	18,600		47,973
1920		1,700		8,350		4,800		1,595		15,200		22,000		53,645
1921		1,800		9,800		5,150		1,600		16,250		26,600		61,200
1922		1,900		11,450		5,500		1,625		17,500		31,400		69,375
1923		2,000		12,750		5,800		1,700		19,000		36,000		77,250
1924	2,021	2,000	14,746	13,750	6,289	6,250	1,793	1,550	19,959	20,600	41,659	40,300	86,467	84,450
1925	2,144	1,900	14,040	14,200	6,767	6,600	1,215	1,400	23,166	23,300	42,592	42,700	89,924	90,100
1926	1,749	1,900	13,882	14,550	7,077	7,200	1,269	1,269	25,316	27,000	46,148	44,300	95,441	96,219
1927	1,869	1,950	15,012	15,200	7,947	8,000	1,360	1,360	32,520	31,600	44,471	45,600	103,179	103,710
1928	2,081	2,050	16,277	16,277	9,245	8,950	1,454	1,360	37,931	36,500	47,384	46,500	114,372	111,637
1929	2,161	2,250	17,770	17,770	9,669	9,900	1,398	1,450	39,781	39,500	49,117	47,300	119,896	118,170

Sources of data:

1909, Dept. of Com., Bur. of Census, Census of the U. S., Statistics for California, 1910: 650-655, Table 4; 1919-1929, data furnished by office of Agricultural Statistician, California Co-operative Crop Reporting Service.

TABLE 19B

ACREAGES AND TRENDS IN THE ACREAGES OF VEGETABLE CROPS IN THE SACRAMENTO VALLEY, 1909-1929

Year	[illegible]		[illegible]		Total	
	Average	Trend	Average	Trend	Average	Trend
1909	5,297	5,200	8,721	9,500	14,018	14,700
1910		5,500		11,000		16,500
1911		5,800		12,300		18,100
1912		6,100		14,000		20,100
1913		6,375		15,300		21,675
1914		6,975		17,000		23,975
1915		7,700		18,500		26,200
1916		8,500		20,000		28,500
1917		9,450		21,000		30,450
1918		10,000		23,000		33,000
1919	4,125	10,025	25,871	25,000	29,996	35,025
1920	9,900	10,025		28,000		38,025
1921	9,400	9,675		25,000		34,675
1922	8,500	9,700		30,000		39,700
1923	9,200	9,600		35,200		44,800
1924	9,200	9,100		36,500		45,600
1925	9,000	9,025		36,000		45,025
1926	9,400	9,500	60,362	39,000	81,962	48,500
1927	9,600	9,600	60,600	41,000	82,800	50,600
1928	9,800	9,700	60,400	42,500	82,200	52,200
1929	9,200	9,200	65,491	43,500	89,991	52,700

Sources of data:

1909, Dept. of Com., Bur. of Census, Census of the U. S. Statistics for California, 1910, 850-68. Table 4, 1910-1929, data furnished by office of Agricultural Statistician, California Co-operative Crop Reporting Service.

TABLE 20B

ACREAGES AND TRENDS IN THE ACREAGES OF MISCELLANEOUS FIELD CROPS, INCLUDING SUGAR BEETS, COTTON AND BEANS, IN THE SACRAMENTO VALLEY, 1909-1929

Year	Sugar beets		Cotton		Beans		Total	
	Average	Trend	Average	Trend	Average	Trend	Average	Trend
1909	7,038	7,000			16,138	16,100	24,079	24,000
1910		7,200				20,000		27,200
1911		7,800				23,000		31,800
1912		8,000				26,200		35,200
1913		8,400				27,500		35,900
1914		8,800				33,000		41,800
1915		8,200				37,500		45,700
1916		8,300				42,500		50,800
1917		8,500				47,700		56,200
1918		8,800				50,000		58,800
1919	1,700	8,400			16,000	40,000	40,371	48,400
1920		8,400			25,200	34,000		42,400
1921		8,800			30,500	33,200		42,000
1922		8,800			30,400	34,200		43,000
1923		9,000			30,400	34,200		43,200
1924	11,300	11,400			25,700	32,000	40,000	47,400
1925		13,000	5,500	7,800	27,800	32,200		54,000
1926		22,800	3,400	5,700	35,000	54,500		83,000
1927		26,400	2,000	4,000	60,000	66,200		96,600
1928		36,500	4,500	6,000	63,000	72,200		114,700
1929		42,500	7,400	7,500	43,000	43,000		93,000
1930	47,845	37,865						

[illegible] on the basis of returns furnished by the Spreckles Sugar Company and the Holly Sugar Company of California.

Sources of data:

1909, Dept. of Com., Bur. of Census, Census of the U. S., Statistics for California, 1910, 850-68. Table 4, 1910-1929, data furnished by office of Agricultural Statistician, California Co-operative Crop Reporting Service.

TABLE 21B

ACREAGES AND TRENDS IN THE ACREAGES OF HAY CROPS IN THE SACRAMENTO VALLEY, 1909-1929

Years	Alfalfa		Grain hay		Other tame hay		Wild hay		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909	57,527	57,500	225,378	225,300	18,334	18,300	17,772	17,700	319,011	318,800
1910		63,000		216,000		17,500		17,200		313,700
1911		68,000		206,200		16,600		16,600		307,400
1912		73,000		197,000		15,800		16,000		301,800
1913		78,000		188,000		14,900		15,400		296,300
1914		83,000		179,000		14,000		14,900		290,900
1915		88,000		170,000		13,200		14,400		285,600
1916		93,000		160,000		12,500		13,800		279,300
1917		98,000		152,000		12,000		13,300		275,300
1918		102,000		142,000		11,600		12,700		268,300
1919	108,000	106,000	133,000	136,000	9,713	11,400	12,100	12,100	262,813	265,500
1920	108,000	109,000	133,000	126,000	10,000	11,100	11,500	11,600	262,500	257,700
1921	110,000	111,500	127,000	117,000	10,000	11,000	11,400	11,000	258,400	250,500
1922	109,000	114,000	117,000	108,000	10,000	10,600	10,500	10,400	246,500	243,000
1923	117,000	116,000	95,000	100,000	10,100	10,600	9,500	10,000	231,600	236,600
1924	119,000	118,000	102,000	92,000	16,300	10,400	5,000	29,400	242,300	229,800
1925	120,000	121,000	63,000	84,000	13,700	10,300	10,500	9,100	207,200	224,400
1926	122,000	123,000	76,000	76,000	9,600	10,100	10,800	8,900	218,400	218,000
1927	126,000	125,000	68,000	70,000	9,200	10,000	10,000	8,700	213,200	213,700
1928	132,000	127,500	66,000	66,000	8,000	9,900	9,500	8,500	215,500	211,900
1929	128,000	131,000	72,000	64,000	11,000	9,700	10,000	8,300	221,000	213,000

Sources of data:

1909, Dept. of Com., Bur. of Census, Census of the U. S., Statistics for California, 1910: 650-655, Table 4; 1919-1929, data furnished by office of Agricultural Statistician, California Co-operative Crop Reporting Service.

TABLE 22B

ACREAGES AND TRENDS IN THE ACREAGES OF CEREAL CROPS IN THE SACRAMENTO VALLEY, 1909-1929

Years	Rice		Corn		Sorghum grains		Wheat		Barley		Oats		Total	
	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend	Acreage	Trend
1909			4,041	4,014	3,544	3,500	185,000	117,500	250,000	250,000	15,811	11,500	447,794	446,544
1910				4,190		4,100		142,500		263,000		17,000		427,890
1911				4,290		4,400		140,000		295,000		18,000		471,000
1912	1,400	1,430		4,300		4,450		140,000		310,000		20,000		490,300
1913	3,100	2,600		4,400		5,100		140,000		315,000		22,000		494,300
1914	14,000	14,000		4,800		6,400		145,000		317,000		23,000		511,700
1915	48,000	50,000		5,200		5,800		150,125		320,000		27,000		544,200
1916	86,000	84,000		5,250		5,100		160,000		325,000		30,000		549,000
1917	77,000	58,000		7,400		6,450		170,000		336,000		32,000		621,850
1918	100,000	100,000		8,800		6,800		182,500		345,000		47,000		690,300
1919	147,500	144,000	14,500	10,000	10,700	7,200	185,000	195,000	335,000	360,000	41,000	55,000	305,500	721,400
1920	165,000	176,000	11,700	10,000	7,000	7,900	215,000	205,000	425,000	375,000	44,000	65,000	633,000	747,700
1921	182,000	197,000	9,000	13,000	8,000	8,500	181,000	212,500	430,000	390,000	57,000	80,000	772,000	793,000
1922	195,000	210,000	8,000	14,000	7,000	9,000	185,000	217,500	380,000	405,000	41,000	87,000	716,000	747,500
1923	198,000	225,000	8,000	14,000	10,000	10,000	190,000	220,000	381,000	410,000	40,000	85,000	747,000	806,000
1924	196,000	240,000	8,000	14,000	11,000	11,000	171,000	222,500	400,000	415,000	31,000	84,000	717,000	811,000
1925	90,000	118,000	7,000	8,000	11,000	11,800	171,000	225,000	400,000	417,000	41,000	85,000	820,000	814,000
1926	102,000	119,000	7,000	7,000	12,000	14,000	210,000	225,000	400,000	415,000	45,000	83,000	806,000	814,000
1927	140,000	134,000	7,000	7,000	15,000	18,000	227,000	227,000	400,000	415,000	31,000	83,000	845,000	885,000
1928	143,000	141,000	7,000	7,000	20,000	22,000	292,000	230,000	474,000	466,000	33,000	85,000	941,000	950,000
1929	116,000	106,000	7,000	7,000	25,000	26,000	232,000	232,500	434,000	490,000	35,000	85,000	849,000	956,000
1930	42,000	110,000	7,000	7,000	30,000	29,000	247,000	235,000	424,000	500,000	35,000	85,000	825,000	956,000

Sources of data

1909, Twogt. of Com., Bur. of Census, Census of the U. S., Statistics for California, 1910, 630-635, Table 4; 1910-1929, data furnished by office of Agricultural Statistician, California Co-operative Crop Reporting Service.

PUBLICATIONS OF THE

DIVISION OF WATER RESOURCES

DEPARTMENT OF PUBLIC WORKS

STATE OF CALIFORNIA

When the Department of Public Works was created in July, 1921, the State Water Commission was succeeded by the Division of Water Rights, and the Department of Engineering was succeeded by the Division of Engineering and Irrigation in all duties except those pertaining to State Architect. Both the Division of Water Rights and the Division of Engineering and Irrigation functioned until August, 1929, when they were consolidated to form the Division of Water Resources.

STATE WATER COMMISSION

First Report, State Water Commission, March 24 to November 1, 1912.
Second Report, State Water Commission, November 1, 1912, to April 1, 1914.
*Biennial Report, State Water Commission, March 1, 1915, to December 1, 1916.
Biennial Report, State Water Commission, December 1, 1916, to September 1, 1918.
Biennial Report, State Water Commission, September 1, 1918, to September 1, 1920.

DIVISION OF WATER RIGHTS

*Bulletin No. 1—Hydrographic Investigation of San Joaquin River, 1920–1923.
*Bulletin No. 2—Kings River Investigation, Water Master's Reports, 1918–1923.
*Bulletin No. 3—Proceedings First Sacramento-San Joaquin River Problems Conference, 1924.
*Bulletin No. 4—Proceedings Second Sacramento-San Joaquin River Problems Conference, and Water Supervisor's Report, 1924.
Bulletin No. 5—San Gabriel Investigation—Basic Data, 1923–1926.
Bulletin No. 6—San Gabriel Investigation—Basic Data, 1926–1928.
Bulletin No. 7—San Gabriel Investigation—Analysis and Conclusions, 1929.
*Biennial Report, Division of Water Rights, 1920–1922.
*Biennial Report, Division of Water Rights, 1922–1924.
Biennial Report, Division of Water Rights, 1924–1926.
Biennial Report, Division of Water Rights, 1926–1928.

DEPARTMENT OF ENGINEERING

*Bulletin No. 1—Cooperative Irrigation Investigations in California, 1912–1914.
*Bulletin No. 2—Irrigation Districts in California, 1887–1915.
Bulletin No. 3—Investigations of Economic Duty of Water for Alfalfa in Sacramento Valley, California, 1915.
*Bulletin No. 4—Preliminary Report on Conservation and Control of Flood Waters in Coachella Valley, California, 1917.
*Bulletin No. 5—Report on the Utilization of Mojave River for Irrigation in Victor Valley, California, 1918.
*Bulletin No. 6—California Irrigation District Laws, 1919 (now obsolete).
Bulletin No. 7—Use of water from Kings River, California, 1918.
*Bulletin No. 8—Flood Problems of the Calaveras River, 1919.
Bulletin No. 9—Water Resources of Kern River and Adjacent Streams and Their Utilization, 1920.
*Biennial Report, Department of Engineering, 1907–1908.
*Biennial Report, Department of Engineering, 1908–1910.
*Biennial Report, Department of Engineering, 1910–1912.
*Biennial Report, Department of Engineering, 1912–1914.
*Biennial Report, Department of Engineering, 1914–1916.
*Biennial Report, Department of Engineering, 1916–1918.
*Biennial Report, Department of Engineering, 1918–1920.

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* Reports and Bulletins out of print. These may be borrowed by your local library from the California State Library at Sacramento, California.

DIVISION OF WATER RESOURCES

Including Reports of the Former Division of Engineering and Irrigation

*Bulletin No. 1—California Irrigation District Laws, 1921 (now obsolete)
*Bulletin No. 2—Formation of Irrigation Districts, Issuance of Bonds, etc., 1922.
Bulletin No. 3—Water Resources of Tulare County and Their Utilization, 1922.
Bulletin No. 4—Water Resources of California, 1923.
Bulletin No. 5—Flow in California Streams, 1923.
Bulletin No. 6—Irrigation Requirements of California Lands, 1923.
*Bulletin No. 7—California Irrigation District Laws, 1923 (now obsolete).
*Bulletin No. 8—Cost of Water to Irrigators in California, 1925.
Bulletin No. 9—Supplemental Report on Water Resources of California, 1925.
*Bulletin No. 10—California Irrigation District Laws, 1925 (now obsolete).
Bulletin No. 11—Ground Water Resources of Southern San Joaquin Valley, 1927.
Bulletin No. 12—Summary Report on the Water Resources of California and a Coordinated Plan for Their Development, 1927.
Bulletin No. 13—The Development of the Upper Sacramento River, containing U. S. R. S. Cooperative Report on Iron Canyon Project, 1927.
Bulletin No. 14—The Control of Floods by Reservoirs, 1928.
*Bulletin No. 15—California Irrigation District Laws, 1927 (now obsolete).
Bulletin No. 15—California Irrigation District Laws, 1929 Revision.
Bulletin No. 19—Santa Ana Investigation, Flood Control and Conservation (with portfolio of maps), 1928.
Bulletin No. 20—Kennett Reservoir Development, an Analysis of Methods and Extent of Financing by Electric Power Revenue, 1929.
*Bulletin No. 21—Irrigation Districts in California, 1929.
Bulletin No. 21-A—Report on Irrigation Districts in California for the Year 1929, 1930.
Bulletin No. 22—Report on Salt Water Barrier (two volumes), 1929.
Bulletin No. 23—Report of Sacramento-San Joaquin Water Supervisor, 1924–1928.
Bulletin No. 24—A Comprised Major Development on American River, 1929.
Bulletin No. 28-A—Industrial Survey of Upper San Francisco Bay Area, 1929.
Bulletin No. 31—Santa Ana River Basin, 1930.
Bulletin No. 32—South Coastal Basin, a Cooperative Symposium, 1930.
Bulletin No. 34—Permissible Annual Charges for Irrigation Water in Upper San Joaquin Valley, 1930.
Bulletin No. 35—Permissible Economic Rate of Irrigated Development in California, 1930.
Biennial Report, Division of Engineering and Irrigation, 1919–1922.
Biennial Report, Division of Engineering and Irrigation, 1922–1924.
Biennial Report, Division of Engineering and Irrigation, 1924–1926.

COOPERATIVE AND MISCELLANEOUS REPORTS

*Report of the Conservation Commission of California, 1912.
*Irrigation Resources of California and Their Utilization (Bul. 254, Office of Exp. Sta. U. S. D. A.), 1912.
*Report, State Water Problems Conference, November 28, 1916.
*Report on Pit River Basin, April, 1918.
*Report on Lower Pit River Project, July, 1918.
*Report on Iron Canyon Project, 1914.
*Report on Iron Canyon Project, California, May, 1928.
*Sacramento Flood Control Project (Revised Plan), 1928.
Report of Commission Appointed to Investigate Causes Leading to the Failure of St. Francis Dam, 1928.
Report of the Joint Committee of the Senate and Assembly Dealing With the Water Problems of the State, 1929.

* Reports and Bulletins all of which may be borrowed by your local library from the California State Library at Sacramento, California.

PAMPHLETS

Rules and Regulations Governing the Supervision of Dams in California, 1929.
Water Commission Act with Latest Amendments Thereto, 1929.
Rules and Regulations Governing the Appropriation of Water in California, 1929
Rules and Regulations Governing the Determination of Rights to Use of Water in Accordance with the Water Commission Act, 1925.
Tables of Discharge for Parshall Measuring Flumes, 1928.
General Plans, Specifications and Bills of Material for Six and Nine Inch Parshall Measuring Flumes, 1930.

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