

IRRIGATION

INTRODUCTION

Scope of the census of irrigation.—The basic inquiries included in the census of irrigation for 1930, taken as a part of the Fifteenth Census of the United States, were (1) the area of land under irrigation, (2) the investment in irrigation enterprises, (3) the character of irrigation enterprises, and (4) the crops grown under irrigation; but inquiries were also made regarding other phases of irrigation, notably, the size, type, and value of irrigated farms and the value of their products, the tenure of their farm operators, source of water supply, and amount of irrigation water used per acre, the physical condition of irrigation works and their capacity to serve, and the drainage of irrigated land.

Territory covered.—The census of irrigation is confined to that part of the United States in which irrigation is a recognized feature of agricultural practice, which includes the following States: Arizona, Arkansas, California, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. In Arkansas and Louisiana irrigation is limited almost entirely to rice growing. In the remainder of the United States irrigation is practiced to a limited extent in the growing of fruit and truck crops by individuals, but most crops are grown without it, and irrigation is merely incidental to accepted agricultural practice; consequently this part of the country is not covered by the irrigation census.

Reports of the Fifteenth Census.—The reports of the Fifteenth Census relating to irrigation are as follows: A report for each of the States covered by this inquiry; a summary for the United States, based on the State reports; and this volume, which consists of the State and United States reports, a general discussion of the results, and several special statistical exhibits not included in the United States summary or the State reports. In addition to these separate reports, a section on irrigation is included in the Abstract of the Fifteenth Census.

Previous reports.—Inquiries relating to irrigation were included in the Eleventh, Twelfth, Thirteenth, and Fourteenth Censuses, and a special census of irrigation was taken in 1902. Reports for all these censuses have been published.

No statistics of irrigation prior to 1889 are available, but in this report all data applying to the enterprises

reported in the Fifteenth Census are classified by their dates of beginning, making it possible to show approximately the progress of irrigation development prior to 1889, although many enterprises established in the early years of irrigation development as well as some of later date are no longer in existence.

Census dates.—The date of the Fifteenth Census was fixed as April 1, 1930, while that of the Fourteenth Census was January 1, 1920. In each case the statistics of farms, of area irrigated, and of crops grown under irrigation relate to the preceding calendar year, so that the change of date did not affect comparisons in any way, the period covered being exactly 10 years. In each case also, the statistics of acreage to which existing enterprises were capable of supplying water relate to the year in which the enumeration was made, and here likewise the period covered in making comparisons was exactly 10 years. In the Fourteenth Census the capital invested in irrigation enterprises was reported as of January 1 of the census year. The canvass of the larger irrigation enterprises included in the Fifteenth Census was started in February, 1930; hence, despite the fact that the agricultural and population enumeration did not begin until April 2, the irrigation schedules called for the investment to January 1, 1930; and enterprises begun after that date were not canvassed. Therefore all comparisons in this report, between the irrigation results of the Fifteenth and Fourteenth Censuses, cover exactly a 10-year period.

Method of collecting information.—The plan adopted in the Fifteenth Census for making the canvass of irrigation enterprises involved the use of two schedules. The simpler of these was used by the enumerators engaged in the canvass of population and agriculture to obtain the reports of individual, partnership, and cooperative enterprises serving one to four farms. For enterprises of other types, and partnership and cooperative enterprises serving more than four farms, a more elaborate schedule was used, as follows: United States Government enterprises were reported direct to the Bureau of the Census by the Commissioner of the Bureau of Reclamation and the Commissioner of the Bureau of Indian Affairs, the separate reports being prepared by local division or project engineers under the supervision of these officials. Others of the group of larger enterprises were canvassed by mail. The mail

canvass preceded the work of the enumerators, which permitted census supervisors to detail conveniently located enumerators who had done good work in reporting the smaller enterprises, to the enumeration also of enterprises which had not already responded by mail. Finally, such enterprises as reported neither by mail nor through the regular enumerators were canvassed by special enumerators, who obtained their reports.

Accuracy of results.—In general, the principal causes of inaccuracy in the irrigation census reports are incompleteness or duplication in the canvass, lack of exact knowledge of facts on the part of those supplying information, carelessness on the part of enumerators in accurately recording the information furnished them, and the errors incident to the handling of so large a mass of statistics in the short time allowed for the work.

There is no way in which the completeness of the irrigation canvass can be determined with absolute certainty, since there are no exact records against which the results can be checked, but irrigated acreage statistics have been compared with all available figures obtained from similar local surveys made by other Government bureaus and State agencies, and, in general, found to be in harmony with them.

The lists used in the canvass of the larger enterprises were compiled from every available Government and State source, were revised by local postmasters, and are believed to have been complete. On the other hand, because the canvass of the individual and partnership enterprises was handled by enumerators engaged in the reporting of agricultural operations for the crop year 1929 only, it is probable that some individual or partnership systems built to serve small areas were omitted from the canvass because of nonuse in 1929, although capable of service then and in 1930. Such nonuse was usually caused by the severe water shortage widely prevalent in the Mountain and Pacific States in 1929 (see p. 13). However, nonuse of small systems and the consequent omission of some of them from the enumeration did not result in misrepresentation of the area actually irrigated in 1929; and since the water shortage characterizing that year had been even more general and only slightly less severe in 1928 and continued in many sections through 1930 and 1931, nonuse of irrigation systems in 1929 in numerous cases may actually have represented their permanent rather than temporary abandonment.

Where comparison with the returns of the 1920 census suggested incompleteness in the 1930 enumerators' canvass, explanations from census supervisors in most cases established the approximate correctness of the 1930 figures. Similar discrepancies applying to large enterprises were either made the subject of correspondence with their officials or were adjusted by employees of the Bureau of the Census following personal interviews with such officials or with other local or State authorities familiar with the facts.

As an offset to errors attributable to omissions, there is the possibility of duplication. Many farms receive water from more than one enterprise and may be included in the areas reported by all the enterprises from which they receive water; some enterprises extend across county lines and may be reported completely more than once; and some enterprises may be known locally by more than one name and may be reported under each. Detection of such duplications was effected with less difficulty in 1930 than in 1920, principally because of changes in the method of making the canvass. Hence many considerable discrepancies appearing in the comparison of 1930 with 1920 statistics reflect not only the elimination from the 1930 results of duplications which were not detected in 1920, but also a corrected distribution of the statistics of extensive intercounty and interstate projects.

The degree of probability of error on account of lack of knowledge of the facts varies considerably with the different inquiries on the irrigation schedules and the different classes of enterprises.

The inquiries which serve for classifying the data by source of water supply and by character of enterprise should be correctly answered, since it is probable that the owners of practically all enterprises, large and small, have exact knowledge of these matters; but classification of areas by character of water rights is not always so simple, especially where rights of more than one status or character are involved. In such cases, classifications were made according to the preponderant rights, where such preponderance was marked; in other cases the data were tabulated under the classification "mixed."

With regard to many of the points covered by the description of irrigation works, a lack of exact knowledge was sometimes evident. Likewise, a proper distinction between main and lateral canals, even on the larger projects, was not always disclosed. Lack of exact knowledge was especially apparent as regarded capacities and lengths of the small canals, capacities of the smaller reservoirs, and of wells, pumps, and engines. Some confusion also appeared in the designations of certain kinds of pumps; specifically, many so-designated centrifugal and rotary pumps are believed actually to be of the turbine type. Most of the owners of pumps and engines are presumed to know the capacities at which the pumps and engines were rated by their manufacturers, but these ratings often vary widely from capacities demonstrated in practice. Most wells have never been tested beyond the capacities of the pumps being used in them, and it is probable that in only a small percentage of cases have the rates of flow been measured. Therefore, the reported capacities of pumped wells represent the owners' estimates of what has been pumped from them, based on the rated capacities of the pumps used, and not on the rates of flow which the wells could produce as

determined by tests or measurements. Similarly, the lifts of most small pumping plants have not been ascertained accurately by farmers, and the reported averages have principal value when compared with those reported in answer to an identical question in 1920, especially for counties where pumping from wells is widespread, since there the comparison should disclose the intervening effect of expanding development or several seasons of pumping, or both, on the position of the underground water table.

The owners of the small individual and partnership irrigation enterprises are likely to have accurate knowledge of the areas irrigated in 1929, since they are also the users of the water, but the officials of many organized enterprises are not so likely to know the exact areas irrigated, since their records show, generally, only the areas for which the water users are entitled to receive water or do receive water, and not what is done with the water delivered. While in the larger enterprises farmers usually obtain rights to water for their entire farms, it is by no means universally the case that a farmer actually applies water to his whole farm, even though he is assessed and pays for water on that basis. For these reasons there is a tendency for the areas reported to exceed the areas actually irrigated. However, increasing numbers of the larger enterprises conduct annual crop surveys, which has tended to make their statements of areas irrigated in 1929 more accurate than those made in previous censuses.

The figures for the area enterprises were capable of supplying with water in 1930 are estimates, based on the condition of the works and the normally available water supply. Here, also, there is a tendency for the area reported to exceed that for which water is actually available.

The irrigable area in enterprises is probably greater, in many cases, than the area to which the enterprises reporting will ultimately be able to supply water. However, since 1920, many of the larger enterprises, especially those which have undergone financial reorganization, have carefully surveyed and scrutinized their lands in order to ascertain the practical extent of their irrigability, considering topography, quality of soils, and quantity of water normally available or expected to be made available. The census of 1920 reported the *total* area in enterprises, which had often been erroneously assumed to be equivalent to the *irrigable* area; but since the later surveys usually resulted in considerable reductions in areas of projects when measured by their irrigability, the question was changed on the 1930 irrigation schedules so as to call for the irrigable, rather than the total area, in enterprises. Both the 1920 and the 1930 figures are shown in this report, but because they are not strictly comparable, no measure of increase or decrease is attempted. The decade, 1920-1930, was marked by

the disappearance of a considerable number of projects which, although in a promotional or early construction stage in 1920, were included in the Fourteenth Census because economic conditions then prevalent gave unfulfilled promise that the systems would be completed as planned. These disappearances also are reflected by the figures for irrigable area in enterprises in 1930, and in some sections by the 1930 figures on investment in enterprises. The latter item does not include expenditures made by abandoned projects or those in preliminary stages in 1930.

The area of land available or to be available for settlement represents the estimates made by officials of enterprises of the area to be irrigated by their enterprises that is not included in farms already settled. There is some tendency toward overestimates of this item.

For investment in irrigation enterprises the amounts reported for the individual and partnership enterprises are almost all estimates. The greater part of the works of such enterprises was built by the owners or their predecessors who kept no records of expenditures of money or time. This is true also of many of the cooperative enterprises. It is probable that the estimates for many of these enterprises are too small. The amounts reported for the larger enterprises are much more likely to be based on records, and therefore to be much more accurate. The totals are believed to be approximately correct.

For many enterprises the cost of maintenance and operation was not reported, and no attempts to estimate this cost were made. It is probable, therefore, that the cost reported is based on records and is correct. In tables showing this item the areas reporting are also shown in order that the reader may form his own judgment as to the value of the averages.

The same condition exists with reference to the data relating to the quantity of water used, which were obtained only from the larger enterprises. No estimates have been made for enterprises by which this item was not reported, and the data representing estimates and those representing measurements are shown separately. In every case the area represented is given to serve as an index to the value of the averages.

The area for which drains have been installed should be accurate, but the additional area in need of drainage is necessarily an estimate, based on the opinion of the persons supplying the information.

The returns for irrigated crops were taken from the general farm schedules. These schedules contained inquiries as to whether all the crops harvested in 1929 were irrigated, whether any of the crops harvested in 1929 were irrigated, and the total acreage in irrigated crops harvested in 1929 in case any were irrigated. If any crop was grown partly on irrigated and partly on dry land, the enumerators were instructed to mark the irrigated crop, and to show also the acreage and

DEFINITIONS AND EXPLANATION OF TERMS

quantity of the crop grown on dry land. Schedules reporting partial irrigation on which the enumerators had marked no crops as being irrigated, were corrected to show as irrigated the crops most likely to have been irrigated in the sections from which the schedules came. The values of irrigated crops were computed from the reported yields and average values per unit obtained jointly by the Bureau of the Census and the Bureau of Agricultural Economics of the United States Department of Agriculture.

The irrigation schedules were all examined in the Bureau of the Census for errors, and in cases in which questions applicable to the enterprises represented were not answered, and in other cases in which answers that appeared to be unreasonable were given, letters were written to those supplying information asking them for additional data. Answers that seemed reasonable were not questioned. Every care was exercised to secure accurate work in tabulation. The results, as a whole, are believed to be substantially correct.

DEFINITIONS AND EXPLANATION OF TERMS

Irrigated land.—The following instructions given to enumerators in 1920 and 1930 show what land was to be reported as irrigated: "Land should be classed as irrigated which has water supplied to it for agricultural purposes by artificial means or by seepage from canals, reservoirs, or irrigated lands, but land which has natural ground water sufficiently near the surface to support plant life should not be classed as irrigated. Land which is flooded during high-water periods should be classed as irrigated if water is caused to flow over it by dams, canals, or other artificial means, but should not be classed as irrigated if the overflow is due to natural causes alone." "Area irrigated" is, therefore, the acreage to which water was actually applied in the seasons (1929 and 1919) preceding the census years of the Fifteenth and the Fourteenth Censuses, respectively. It is not necessarily the area for which water was available nor the area entitled to water; hence it does not include land under canals and sometimes irrigated but which was not watered in 1929 (or 1919), nor land not yet cropped nor irrigated on farms then in process of reclamation. Moreover, it takes no account of the degree of sufficiency of the irrigation.

"Area enterprises were capable of supplying with water" relates to the year of the census (1930 or 1920). It is based on estimates made by those controlling the enterprises, and represents the area which the constructed works and the controlled and normally available water supply could serve, regardless of whether or not the land was farmed in the census year.

Irrigable area in enterprises (1930) and *Total area* in enterprises (1920) represent the extent of the plans of those controlling the enterprises. The terms are not synonymous, irrigable area comprising only that portion of the total area within the boundaries of projects which is susceptible of being irrigated ultimately, even though not all of it was irrigated in 1929. Possible extensions of projects not definitely planned in 1930 are not included in the area reported as irrigable.

Irrigated areas (1929), irrigable areas (1930), and areas enterprises were capable of supplying (1930) are *net*; i. e., they do not include known duplications representing areas served or susceptible of being served by more than one enterprise.

"Area of irrigated land reported as available, or to be available, for settlement" relates to land within operating enterprises and not to land susceptible of reclamation and settlement by enterprises not included in the Fifteenth Census. It is limited to land for which water is available or is to be made available but which is not yet settled. Land already settled is not included, even if for sale, unless it is to be subdivided, in which case only the parts that are to be sold for new farms are considered as available for settlement. If the management of an enterprise is farming land pending its settlement, the land is reported as available for settlement.

Irrigation enterprise.—An "enterprise" is an independent irrigation establishment and includes the works for supplying water and the land to which water is supplied, or is to be supplied, except that the cost or value of the land is not included in the "investment" in the enterprise. Only such enterprises as supplied water for irrigation in 1929, or were capable of supplying water for irrigation in 1930, or were in advanced stages of construction, January 1, 1930, are included in the Fifteenth Census. The 1930 totals take into account various consolidations made since 1920.

An enterprise may represent a small canal or pumping plant watering a single small farm, or a great system of canals and reservoirs operated under one management supplying thousands of farms; hence the number of enterprises is of importance chiefly if it indicates the character of the development effected by the enterprises reporting.

Presentation of the statistics by counties requires that for an enterprise comprising land in more than one county the part in each county be considered a separate enterprise. However, the actual number of enterprises, eliminating such duplications, is shown in State and United States summary tables showing areas by dates of beginning and investment by character of enterprise.

Character of enterprise.—The characters of enterprises under which all data are classified are as follows:

Individual and partnership enterprises, which belong to individual farmers or to neighboring farmers, who control them without formal organization. State laws provide the procedure for compelling part owners in partnership canals to contribute their share of the labor and expense of maintenance and operation.

A number of small enterprises, heretofore classified as partnerships, have incorporated since 1920, and are now included in the "cooperative" group.

Cooperative or mutual enterprises, which are controlled by the water users, under some organized form of cooperation. The most common form of organization is the stock company, the stock of which is owned by the water users. Some States have special laws providing for the organization of such stock companies, and in those States in which they are organized under general incorporation laws there are laws regulating their actions to some extent.

Many of the enterprises now reported as cooperative were originally in some other class and have become cooperative through various processes of reorganization.

In the Southwest, where irrigation was practiced before this region became a part of the United States, much of the land is watered by "community ditches," or "public acequias," which are organized and operated in accordance with old Mexican customs providing for the election of officials by the landowners and for forced labor on repairs and cleaning. These enterprises are classed as cooperative. Included also in the cooperative classification are the "district improvement" companies of Oregon, which represent a special type of development enterprise differing somewhat from the irrigation district, although having a semipublic status; a few companies which have superseded irrigation districts; a larger number of "lateral" companies, the chief function of which is to handle the distribution of water to their members beyond the places where the responsibility of their parent enterprises terminates; various storage companies controlled on a cooperative basis by groups of other enterprises; and a few "mutual" companies, especially in southern California, which expect eventually to supply their members with water for domestic purposes only, but which meanwhile use their surplus supplies for irrigation. (See also "United States Bureau of Reclamation enterprises.")

Irrigation districts, which are public corporations established under State laws empowering them to issue bonds to obtain funds for the purchase or construction of irrigation works, and to levy and collect taxes or assessments for the payment of bonds and interest on them, and for the payment of the cost of maintenance and operation. The term "irrigation districts" also includes water-improvement districts, water-conservation districts, and water-storage districts, which in some States are in addition to irrigation districts and in other States are in lieu of them.

Irrigation districts are controlled by the owners of the lands forming them through boards of directors elected by the landowners. Some districts are organized for the purchase of irrigation works built by other agencies; others, for the purpose of building new works. In this report all enterprises now operating as districts, except those which have taken over and now operate works built by the United States Bureau of Reclamation, are reported as districts. (See also "United States Bureau of Reclamation enterprises.")

A few districts which have the sole function of storing water for other enterprises, are included in the "irrigation district" classification.

Carey Act enterprises, established under the Federal law of August 18, 1894, granting each of the States in the arid region 1,000,000 acres of land on condition that the State provide for its irrigation, and under amendments to that law granting additional areas to several of these States, if applied for. The conditions contained in this law necessitate State legislation before the law becomes operative; thus Carey Act enterprises operate under both Federal and State laws.

The State laws governing operations under the Carey Act provide that works built under these laws shall be turned over to stock companies composed of the water users when certain payments have been made. Some of the original Carey Act

companies have been reorganized as irrigation districts, and one is now classified as a United States Bureau of Reclamation enterprise, but most of them, upon reorganization, have become cooperative companies and so appear in the 1930 classifications.

Commercial enterprises, incorporated or otherwise, which supply water for compensation to farmers who own no interest in the works. Such enterprises may be organized in any form, but their operations are subject to some degree of public control in most States. This was the earliest type of enterprise for the construction of large irrigation works. Such enterprises built irrigation works and sold rights entitling the purchasers to receive water from their works upon the payment of annual charges, but conveyed no interest in the works. Many of the States have enacted laws prohibiting the sale of such rights, and commercial enterprises organized since the passage of these laws usually sell stock representing part ownership in the works, to become effective upon the payment of specified portions of the purchase price. These enterprises eventually become cooperative. There are some commercial enterprises that sell no rights but supply water to the public for charges based, in some instances, on acreage served, and in other instances, on the quantity of water delivered. In most States rates charged by commercial enterprises are subject to public control.

United States Bureau of Indian Affairs enterprises, which operate under various acts of the Congress providing for the construction by that bureau of works for the irrigation of land in Indian reservations.

United States Bureau of Reclamation enterprises, established under the Federal law of June 17, 1902, which provided for the construction of irrigation works with the receipts from the sale of public lands, and subsequent legislation which provided other funds. In addition to serving land within its own projects, the United States Bureau of Reclamation supplies stored water to land within other enterprises. Statistics classified as "United States Bureau of Reclamation" do not include those for such water purchasing enterprises, since the latter are represented in other classifications.

The United States reclamation act provides that when the payments required by that act are made for the major portion of the lands in any enterprise, the management and operation of the works shall pass to the water users "under such form of organization * * * as may be acceptable to the Secretary of the Interior." Originally the Secretary of the Interior favored the organization of farmers' cooperative companies or "water-users' associations" for taking over the projects, but more recently he has favored the organization of irrigation districts. Actual operation of several projects or project units has been assumed by water-users' associations or irrigation districts, but in no case have construction expenditures made by the Government been repaid in full by such associations or districts, nor has title to the major irrigation works passed to them; hence all projects in this status are classified as United States Bureau of Reclamation enterprises.

State enterprises.—In a few instances, the States themselves have carried out irrigation development enterprises under special legislation, but with the exception of two established by the State of California all such projects have been reorganized and their statistics appear in other classifications. However, "State" enterprises include also various institutions having independent irrigation systems serving their own lands exclusively.

City water and city sewage-disposal enterprises.—A few cities dispose of sewage by utilizing it for irrigation. Others, notably in Utah and California, maintain irrigation service in conjunction with their domestic service. Statistics for both such enterprises are grouped under this classification.

Other enterprises are those reporting the operation of irrigation works, which do not fit into the classifications outlined above. Notable in the group are a few enterprises established as

"drainage" districts, but which operate irrigation as well as drainage systems; and a somewhat larger number of "reclamation" districts. Most of the latter have flood control or drainage, or both, as their principal function, irrigation being of varying importance but usually subordinate to flood control. Reclamation districts have no connection with United States Bureau of Reclamation enterprises, being organized and operated under State laws.

Figures for dual-purpose enterprises, such as city enterprises maintaining irrigation departments in conjunction with their domestic service, were adjusted before being tabulated so as to confine them as closely as possible in each case, to irrigation service alone, except that such adjustments were not attempted in the cases of enterprises, the functions of which relate predominantly to irrigation. For instance, statistics of several large enterprises operating drainage wells the discharge of which is used for irrigation, include such wells, their pumps and motors, the investment in them and the cost of their maintenance and operation, without reduction on account of the drainage feature.

However, adjustments were made to avoid duplications, especially in acreage figures, between water-storage projects and the water-distributing enterprises comprising them. In some such cases the *net* figures are attributed to the storage enterprises; in others, to the distributing enterprises, the determining factor in each case being the apparent predominance of one or the other type in the control of the irrigation supply; i. e., if the stored water were the main dependence of the community, the adjustment favored the storage enterprise, but if the gravity rights of the distributing enterprises were their main dependence, the classification favored them.

Investment in irrigation enterprises.—The investment in irrigation enterprises is that reported by the owners, and represents investments by their predecessors only in cases where changes of ownership have not involved changes in investment. For the larger works the investment is taken, in most cases, from books of account and represents actual outlays. In the case of many private, partnership, and cooperative enterprises, however, the works were built by farmers who kept no records of money or labor expended, and the investment reported represents estimates. The investment includes cost of construction and cost of acquiring rights. The latter usually consists of filing fees only, but in some instances it includes litigation and the purchase price of rights. For the Fifteenth and Fourteenth Censuses the average investment per acre is based on the area enterprises were capable of supplying with water and on the investment to January 1, 1930, and January 1, 1920, respectively.

Estimates for investments in such enterprises as did not report amounts were computed by multiplying the number of acres to which those enterprises were capable of supplying water in the census year, by the average investment per acre reported by other enterprises

of similar characteristics and age in the same or adjacent counties. Enterprises not reporting investment were chiefly those built by pioneer farmers who kept no records of their labor or expenditures.

Maintenance and operation.—Cost of maintenance and operation was not reported by all enterprises, and averages are based on the areas irrigated in 1929 for which cost was reported. No estimate of total cost of maintenance and operation for all irrigation enterprises has been made, but if such a total be desired it is probable that one obtained by applying the average cost per acre in each State to the total area irrigated in that State and adding these totals for a United States total would be approximately correct. For enterprises operating pumping plants the cost of maintenance and operation includes cost of fuel and attendance. In all cases the acreages on which the averages are based are given to serve as guides to the value of the averages.

Estimated cost of preparing land for irrigation.—This average represents the best estimates obtainable from the officials of enterprises reporting, or from farmers on the land, on the cost of clearing and grading land, and building farm laterals and farm irrigation structures. It is not included in the "investment in irrigation enterprises."

Water rights.—A water right is a right to take and use water from some specified source and to continue such taking and using of water from year to year. Water rights are divided into two general classes, with reference to the source of supply: (1) Rights to take water from natural sources, and (2) rights to take water from artificial sources, such as irrigation canals, which receive water from natural sources. The nature and extent of rights of the first class are governed by State laws, while those of the second class are governed by contracts, rules, and regulations of irrigation enterprises.

There are in effect in the States where irrigation is practiced two more or less conflicting systems of laws governing water rights: (1) The English common-law doctrine that the right to use water from a stream or other body of water attaches to land abutting on the stream or other body of water, known as the riparian doctrine; and (2) the American doctrine that water may be taken from streams without reference to the location of the place of use, known as the doctrine of appropriation.

In all States where irrigation is practiced rights by appropriation are recognized, and some of the States recognize riparian rights also. In the reports contained in this volume the irrigated land has been classified by the character of rights under which it receives water. The classes used are defined as follows:

Appropriation and use.—In most of the States irrigation began before the States assumed control over water, and those needing water took it and used it. Their rights to continue the

use were recognized by the courts and later by legislation, and many rights have no other basis.

Notice filed and posted.—The first step in public control of the use of water was the enactment of laws requiring those wishing to acquire rights to water to post at the points where water was to be taken notices of their intentions, or to file such notices with county officials, or both to post and file notices. These were to serve as notification, to those coming later, of the existence of the prior rights represented by the notices. In many of the States, laws required all parties who had appropriated water before the passage of the laws to file notices of their claims, with the object of making complete records of rights, and many rights originally acquired by appropriation and use passed into this class.

Adjudicated by court.—Rights acquired by appropriation and use and those represented by notices filed and posted, while they are recognized by law, are not defined as to extent or priority, since in the first class there is no record on these points, and in the second class the records may bear no relation to the facts. When rights come into conflict they are carried into the courts and are then defined or adjudicated, and pass from the other classes into this class. Most of the States have laws providing special procedure for water-right cases.

Permit from State.—The evident disadvantages of having rights undefined until they come into conflict and are adjudicated by courts, and the advance in the completeness of public control have led in most States to the enactment of laws requiring parties wishing to acquire rights to apply to some State official or board for permits. These applications must set forth in detail what is intended, and in their approval the boards and officials fix conditions as to extent of rights and time within which works must be completed, etc. Rights are not complete until proof of compliance with the prescribed conditions has been submitted and certificates are granted by the State, but they are defined as they are acquired rather than only after they come in conflict with other rights. Rights reported in this class are in the process of being acquired rather than vested.

Certificate or license from State.—The States having laws requiring applications for permits provide for the issuing of certificates or licenses when works have been completed and water put to use in accordance with the terms of the permits issued, and some of the States provide also for the issuing of certificates when older rights are adjudicated by courts or administrative boards. This class includes all rights represented by such certificates or licenses, and may include rights originally in any one of the other classes named.

Riparian rights.—Rights in this class are those based on the ownership of land abutting on the source from which water is taken, in the States which recognize such rights. The most common interpretation of riparian rights in the Western States is that the owner of riparian land may make any reasonable use of the water that will not interfere with a like reasonable use by all other owners of land riparian to the same source. Under such an interpretation the right is not fixed as to extent or nature, but depends upon the number of other owners and their needs.

Underground.—In most States public control of the use of water has not extended to wells, and consequently these have been put in a class by themselves. This class includes land watered from wells, which, with some exceptions, does not hold rights of the other classes.

Source of water supply.—The classes of sources of water supply into which all data are divided are self-explanatory, except as regards the 1929 areas shown as irrigated by "supplemental" pumping. These areas are included in enterprises irrigated by gravity diversions from streams, springs, or lakes, or from other sources which usually or occasionally are depleted in

midsummer before crops can be brought to maturity. In such emergencies the pumps are operated to supplement the depleted supplies. A duplication of area statistics is avoided in tables showing sources of supply, by omitting from the totals the land served by the supplemental pumps.

Date of beginning.—The date of beginning of an irrigation enterprise is, in some cases, the date when construction began, and, in other cases, the date of filing a claim or of applying for a permit. If a filing or application for permit was made and work was begun and continued with reasonable diligence, the date of filing is considered the date of beginning; otherwise, the date of construction is taken as the date of beginning. This classification should indicate the extent to which the plans of promoters of irrigation enterprises are realized in various periods of time after their beginning, which is an important factor in financing irrigation enterprises. However, dates reported are those applying to the operations of the reporting enterprises and not to their predecessors.

Classification of works and equipment by date of beginning does not necessarily indicate that the specified works were begun in the specified periods, since the age groups apply to the enterprises reporting and not to the works themselves. Thus, pumping plants reported in 1930 by enterprises established before 1860 may have been installed by those enterprises in the years between 1925 and 1929, or in any other period than that preceding 1860.

Drainage basins.—The drainage basin of a stream consists of all land drained by the stream and its tributaries, including land irrigated by flowing or pumped wells. Accordingly, irrigated land is credited to the drainage basin in which it lies, although in a few cases it is irrigated with water carried over from other basins.

Main canals and laterals.—A main canal is any irrigating channel conveying water from the source of supply to the tract of land to be irrigated or to a storage reservoir. A lateral canal is a branch of a main canal conveying water from a main canal to one or more farms. Farm laterals, which distribute the water within the boundaries of the individual farm, are not reported.

Dams.—Many of the diversion dams reported in both 1930 and 1920 are temporary structures of sand, rock and brush, or other easily accessible materials which serve to direct early-season stream flows into small canals. Tables classifying dams by material include these temporary diversion dams as "Other and mixed" because of the variety of materials composing them. Most such dams wash out and have to be replaced annually or more frequently.

Average lift of pumps, in feet, is the static lift or the average vertical distance between the level of the water in the source of supply when the pumps are

running and the point to which the water is lifted. It does not take into account friction and velocity heads.

Units of quantity and capacity.—Capacities of canals, reservoirs, wells, pumps, and engines, and quantities of water used are expressed in the following units:

Capacities of canals and rates of flowing water are given in second-feet ("sec.-ft."), a shorter equivalent for cubic feet per second.

Capacities of wells and pumps are given in gallons per minute ("g. p. m."). Four hundred and fifty gallons per minute equal 1 second-foot.

Capacities of reservoirs are given in acre-feet ("ac.-ft."). An acre-foot of water is the quantity that will cover 1 acre to a depth of 1 foot. It equals 43,560 cubic feet.

Capacities of engines and motors are given in horsepower ("h. p."). One horsepower is the power required to lift 33,000 pounds through a vertical distance of 1 foot in 1 minute of time.

Farm and irrigated farm.—A "farm," for census purposes, is all the land which is directly farmed by one person, either by his own labor alone or with the assistance of members of his household or hired employees. The land operated by a partnership is likewise considered a farm. A "farm" may consist of a single tract of land, or of a number of separate tracts, and these several tracts may be held under different tenures, as when one tract is owned by the farmer and another tract is rented by him. When a landowner has one or more tenants, renters, or managers, the land operated by each is considered a farm. Thus on a plantation the land operated by each cropper or tenant was reported as a separate farm, and that part of the land operated by the owner or manager by means of wage hands likewise was reported as a separate farm. The enumerators were instructed not to report as a farm any tract of land of less than 3 acres, unless its agricultural products in 1929 were valued at \$250 or more.

The definition of a farm for 1920 contained an additional provision with regard to a farm of less than 3 acres, as follows: "* * * or which required for its agricultural operations the continuous services of at least one person." It is possible that the difference in the number of farms shown for 1930 as compared with 1920 is to some extent due to this change in the definition of a farm.

The Bureau of the Census reports a farm in the county in which the farm or ranch operating headquarters are located. This, in some instances, affects the figures for farm acreage and total crop acreage as compared with the total land area, irrigated area, and irrigable area, because a number of farms and ranches extend across the boundaries of counties and even across State lines.

Irrigated farms are those reporting the irrigation of any land whatsoever in the censuses of 1930 and 1920 for the crop years 1929 and 1919, respectively. "Wholly irrigated" farms include those reporting the irrigation of all harvested crops and of all land from which no

crops were harvested because of failure; also, farms without crops, reporting the irrigation of all pasture land. "Partly irrigated" farms are those reporting the irrigation of part but not all of such crop land or pasture land.

The "number of farms irrigated" is equivalent to "number of irrigators" shown in census reports previous to 1910.

Land in farms.—The acreage designated as "Land in all farms" includes considerable areas of land not actually under cultivation and some not even used for pasture, since each farmer was asked to report as a unit all the land under his control, or rather all the land which he thought of as a part of his farm. Isolated tracts of timberland and other areas not connected with the farm were not included.

Land in irrigated farms, 1930, is the area of the farms which were wholly or partly irrigated in 1929.

Farm values.—The farmer was asked to report, first, the total value of his farm (land and buildings), including all the land which he operated, both owned and hired, whether operated for himself or managed for others. He was asked to give the current market value—that is, the amount for which the farm would sell under normal conditions, not at forced sale. The tabulated results of this inquiry are shown as value of "Land and buildings" and represent the total value of farm real estate. The values of irrigated farms are thus the 1930 values of farms which were wholly or partly irrigated in 1929.

The farmer was also asked to report the value of all farm buildings on his farm and of his dwelling house alone. These values were necessarily estimated, and the figures obtained are probably somewhat less satisfactory than the figures for the total real-estate value.

The figure shown for "Land alone" is obtained by subtracting the value of the buildings from the basic value of land and buildings together.

The value of farm implements and machinery is the combined value of automobiles; trucks; tractors; tools; wagons; harnesses; dairy equipment; cotton gins; threshing machines; combines; apparatus for making cider, grape juice, and sirup, and for drying fruits; and all other farm machinery. The value of commercial mills and factories located on the farm was not included.

Tenure of farm operator.—A "farm operator," according to the census definition, is a person who operates a farm, either performing the labor himself or directly supervising it.

"Owners and managers," as classified in the 1930 irrigation census, include full owners, part owners, and managers, and "tenants" include cash tenants, croppers, and other tenants.

Full owners are farm operators who own all the land which they operate.

Part owners are farm operators who own part of the land which they operate, and rent and operate addi-

tional land. Part owners, therefore, have some of the characteristics of full owners and some of the characteristics of tenants.

Managers are farm operators who operate farms or ranches for the owners, receiving wages or salaries for their services.

"Tenants" are farm operators who operate hired land only. They include (1) *cash tenants*, who pay a cash rental, as \$7 per acre for crop land or \$500 for the use of the whole farm; (2) *croppers* (reported only for the Southern States), who are defined as share tenants, to whom landlords furnish all the work animals; and (3) *all other tenants*, including those giving a share of the products for the use of the land or a share for part and cash for part.

Size of farm.—In adopting the size classification, the Bureau of the Census took into account the fact that in large sections of the country, especially those included in the irrigation census, the boundaries of many farms correspond more or less closely to the Government surveys of public lands. Government land has been disposed of in quarter-sections of 160 acres or approximately that amount; and where they have been broken up they have commonly been divided into 40-acre tracts. Many farms, therefore, in much of the country, contain either 160 acres or some other multiple of 40 acres. Hence, most of the small farms are in the East and South, while most of the very large farms are in the West.

Type of farm.—In counting irrigated farms according to type, no distinction was made between *wholly* irrigated farms and *partly* irrigated farms. The following types of farms, based on the principal source of income, have been distinguished: General, cash-grain, cotton, crop-specialty, fruit, truck, dairy, animal-specialty, stock-ranch, poultry, self-sufficing, and abnormal and unclassified.

The "abnormal type" is a consolidation of five subtypes which are not carried in this volume. These subtypes are as follows: Institution or country estate; part-time; boarding and lodging; forest-product; and horse farm, feed lot, or livestock dealer.

Source of income, that is, the value of products from a particular source in relation to the value of products from all sources, is the primary basis used in classifying the farm by type. "Source" relates to the product or products from which the income is derived, resulting from the sale of a single product in certain cases, and from the sale of a group of products in other cases. Products used on the farm itself are not included except those for family consumption, which are combined into one total.

The values are calculated as follows:

Crops include grains, cotton, tobacco, hay, vegetables, fruits, plants, flowers, and all other crops harvested in 1929 which had been, or were to be, sold or traded.

Livestock includes all domestic animals, sold or traded in 1929.

Livestock products include milk, cream, butter, butterfat, meat, poultry, eggs, honey, wool, mohair, and other livestock products, sold or traded in 1929.

Forest products include saw logs, veneer logs, firewood, pulpwood, fence posts, railroad ties, poles, piling, bark, turpentine, gum, etc., sold in 1929.

Farm products used by the family include the estimated value of meat, milk, poultry, eggs, honey, vegetables, fruits, firewood, etc., furnished by the farm for the use of the family of the operator in 1929.

Receipts from boarders, lodgers, campers, etc., include income received from boarders, lodgers, campers, etc. (Value of board and lodging furnished persons working on the farm is excluded.)

The total value of all products includes the value of crops, livestock and livestock products sold or traded, forest products sold, and products used by the operator's family; but excludes receipts from boarders, lodgers, etc.

For nine of the major types—cash-grain, cotton, crop-specialty, fruit, truck, dairy, animal-specialty, stock-ranch, and poultry—the classification was determined on the basis of 40 per cent or more of the total value of all products of the farm coming from that particular source. For each of these types, sales (or anticipated sales) of the following products, or groups of products, had to represent 40 per cent or more of the total value of all products of the farm, in order that it should be so classified:

Cash-grain.—Corn, wheat, oats, barley, flax, rye, spelt, buckwheat, rice, and grain sorghum.

Cotton.—Cotton (lint) and cottonseed.

Crop-specialty.—Sweet sorghum for sirup, sugarcane, sugar beets, maple sugar and sirup, soybeans, cowpeas, velvetbeans, ripe field peas and beans, tobacco, hay, peanuts, white potatoes, sweetpotatoes, mushrooms, and other minor field crops.

Fruit.—Small fruits, such as strawberries, raspberries, blackberries, cranberries, etc., and all tree fruits, nuts, and grapes.

Truck.—All vegetables sold.

Dairy.—Milk, cream, butterfat, butter, and dairy cows and calves.

Animal-specialty and stock-ranch.—All classes of beef cattle, sheep, hogs, wool, mohair, and slaughtered animals.

The chief distinction between stock ranches and animal-specialty farms lies in the ratio of the pasture land to the crop land. A stock ranch is a type of organization in which chief emphasis is placed on the production of livestock (usually beef cattle, sheep, or goats) *by grazing*; while an animal-specialty farm is one in which more emphasis is placed on the production of crops and *feeding* of livestock (usually hogs, beef cattle, or sheep).

Because of the fact that the quality of pasture varies so widely in different parts of the country, it was found necessary, in differentiating ranches from animal-specialty farms, to use two limits for this ratio of crops to pasture, one for the territory lying, roughly, east of a line extending north and south through the approximate middle of the States of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas, and the other limit applying to the area west of this line.

Thus a farm was classified as a "stock-ranch" where the acreage in pasture was 5 times (east of designated line) or 10 times (west of designated line) the acreage in crops; and as an

"animal-specialty" farm where the acreage in pasture was less than 5 times (east of designated line) or 10 times (west of designated line) the acreage in crops.

In the Western States, farms reporting considerable numbers of cattle or sheep and little or no pasture land, but which were evidently using public land for grazing, were classified as stock ranches.

Poultry.—Chickens, ducks, geese, turkeys, and chicken eggs.

General.—Farms were classified as "general" where the value of products from any one source was less than 40 per cent of the total value of all products of the farm. If a value of products from each of two sources represented 40 per cent or more of the total, the farm was classified as "general," except for specialized combination types, such as cotton-tobacco, fruit-truck, etc., when it was classified as one or the other of the types depending on which was dominant in the locality.

Self-sufficing farm.—Where the value of farm products used by the operator's family was 50 per cent or more of the total value of all products of the farm it was classified as self-sufficing.

Abnormal farm.—This type includes five subtypes. For certain of the abnormal farms the classification by subtype was determined on the basis of 50 per cent or more of the total value of all products of the farm coming from a particular source. The subtypes are defined specifically as follows:

Institution.—Where the farm was owned or operated by a public or semipublic agency; for example, a school, college, church, foundation, asylum, etc. **Country estate.**—Where the value of the residence was \$25,000 or more on farms of 10 acres and over.

Part-time.—Where the operator spent 150 days or more off the farm, in other than farm work, or reported an occupation other than farmer, provided the value of products did not exceed \$750.

Boarding and lodging.—Where the receipts from boarders, lodgers, campers, etc. represented 50 per cent or more of the total value of all products and receipts of the farm.

Forest-product.—Where the value of forest products sold represented 50 per cent or more of the total value of all products of the farm.

Horse farm.—Where the value of horses or mules sold represented 50 per cent or more of the total value of all products of the farm, and when from inventory items on the schedule it was evident that the principal business was the production of horses or mules. **Feed lot.**—Where the value of beef cattle, sheep, and hogs sold represented 50 per cent or more of the total value of all products of the farm, the acreage in the farm was small, little or no crop production, and large expenditures for feed. **Livestock dealer.**—Where large numbers of livestock were reported under both purchases and sales, little or no feed crops being either produced or purchased, little or no pasture shown, and the operator reported an occupation other than farmer and spent a number of days off the farm in other than farm work, and where the value of livestock sold represented 50 per cent or more of the total value of all products of the farm.

Unclassified.—Where the farm was *not* operated in 1929, or where there was an incomplete report of the quantity of crops and livestock produced and sold, or where other information was missing or incomplete the farm was not classified by type.