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PRESENT-DAY AGRICULTURE IN ARIZONA

By the Staff

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§In cooperation with United States Department of Agriculture, Bureau of Plant Industry.

FOREWORD

Many hundreds of letters are received each year by the College of Agriculture of the University of Arizona requesting information about farming conditions and livestock growing in this State. A considerable proportion of these letters are from farmers in the East and Northwest who are desirous of making a change and who may come to Arizona and either homestead or buy land, and make this their future home. These inquiries have become so numerous that it has seemed wise to assemble this information briefly in bulletin form and thus render it more complete and more readily available. This bulletin has, therefore, been written chiefly for residents of other states who are interested in Arizona's agriculture.

Arizona is the youngest state in the Union and, with less than 1 percent of its total area under cultivation, we feel that it should have a bright agricultural future when the present depression has passed and farming again assumes its rightful place in the business world. A factor of great importance to its agriculture, and one duplicated in few other states, is its great diversity of climate which permits successful growing of dates, citrus fruits, figs, and long-staple cotton on the one hand, and the hardier horticultural and field crops on the other. These climatic differences are brought about largely by elevation. The northern half of the State is a high plateau, 5,000 to 7,000 feet above sea level, while the southern part is a vast, low-lying, semi-arid desert. Some farming without irrigation is practiced in the former, while irrigation is required in the latter. About three-quarters of the land under irrigation is in the Salt River and Yuma valleys. The climate in northern Arizona is similar to that found in the Middle West although the rainfall is less. Southern Arizona enjoys delightfully mild winters but very hot, dry summers.

While certain tracts of public lands in Arizona are still available for homesteading, all of the better areas have long ago been taken up. That which remains is often rough, inaccessible, and impossible to irrigate. Information about Government lands still open for settlement can be obtained directly from the State Land Office at Phoenix, Arizona.

THE DIRECTOR.

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INTRODUCTION

Of the 48 states, Arizona is fifth in size. It has a total area of 113,956 square miles or 73,931,840 acres. It is approximately as large as the New England States and New York State combined. More than 70 percent of the total area of Arizona is occupied by United States Government Indian and National Forest Reservations under the control of Federal Bureaus. However, much of this land is leased by the Government to livestock men for grazing purposes.

The tabular material reported in this bulletin was taken or calculated from the Federal Census for 1930, from Yearbooks of the United States Department of Agriculture, and from local sources. While the data may not in all cases be absolutely correct, they are as close as could be computed from existing statistics. From the Arizona Industrial Congress Reports we learn that the total value of farm products for the year 1929 was estimated at $52,000,000 from 650,000 acres of tilled land. Shipments of cattle to outside markets for this year amounted to about 220,000 head and slaughterings amounted to 80,000 head, giving cattle sales an estimated value of approximately $13,000,000. Shipments of 375,000 lambs, 50,000 old ewes, 5,200,000 pounds of wool and 750,000 pounds of mohair brought the value of sheep and goat production to about $4,500,000. While lumbering is not definitely an agricultural industry, it may not be out of place here to state that during 1929 approximately 160,000,000 board feet were cut representing something over $4,000,000 in value.

Table 1 shows the amount of money invested in the more important agricultural industries in the State of Arizona, each divided between land and buildings, implements and machinery, and livestock. The totals are also shown graphically in Figure 1. Brief explanations of the terms used in this classification are as follows:

General. Where the value of products from any one source is less than 40 percent of the total value of all products sold, the farm is classified as "general."

Grains and Sorghums. Corn, wheat, oats, barley, rye, buckwheat, and grain sorghums.

TABLE No. 1.—MONEY INVESTED IN DIFFERENT AGRICULTURAL INDUSTRIES IN ARIZONA.

(Computed from the 1930 U. S. Census Reports and U.S.D.A. Yearbook figures.)

Type of farm	Land and buildings	Implements and Machinery	Livestock	Total
General	7,959,400	529,000	1,015,700	9,504,100
Grains & Sorghums	2,085,400	110,000	141,500	2,336,900
Cotton	64,089,800	3,659,100	1,785,500	69,534,400
Other Field Crops	10,942,100	586,400	597,200	12,125,700
Fruits - Nuts	20,207,800	527,300	90,400	20,825,500
Truck	9,386,400	748,300	218,500	10,353,200
Dairy	11,798,900	768,100	1,982,500	14,549,500
Stock Finishing	3,702,400	259,000	1,547,400	5,508,800
Range Livestock	27,370,000	1,458,300	39,912,400	68,740,700
Poultry	3,972,300	268,600	422,700	4,663,600
Self Sufficing	2,232,700	167,800	412,500	2,813,000
Unclassified	20,483,700	1,332,200	6,246,400	28,062,300
Total all types	184,230,900	10,414,100	54,372,700	249,017,700

Cotton. Lint and cotton seed.

Other Field Crops. Hay, leguminous crops, potatoes, and other minor field crops.

Fruits and Nuts. Citrus and deciduous fruits, small fruits, grapes, dates, and nuts (chiefly pecans).

Truck. Head lettuce, peas, cauliflower, asparagus, sweet onions, cantaloupes, and table vegetables.

Dairy. Dairy cows and calves, milk, butter, and cream.

Stock Finishing. All classes of beef cattle, sheep, and hogs being fattened for slaughter in pasture or in feed lots; also wool and mohair.

Range Livestock. Beef cattle, sheep, and goats grazed on the open range with practically no cultivated crops fed, and little or no irrigated pasture land used.

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

Self Sufficing. Where 50 percent or more of all farm products produced are consumed by the operator's family.

Unclassified. Land owned and operated by the State or a public agency, guest ranches, private estates, forest products, breeding farms, and farms not operated in 1929.

From these data, it will be seen at once that more than one-half of all moneys invested in agricultural production in the State of Arizona are in cotton and in range livestock; also that they are about equally divided. In fact, the annual incomes for the year 1929 were: from cot-

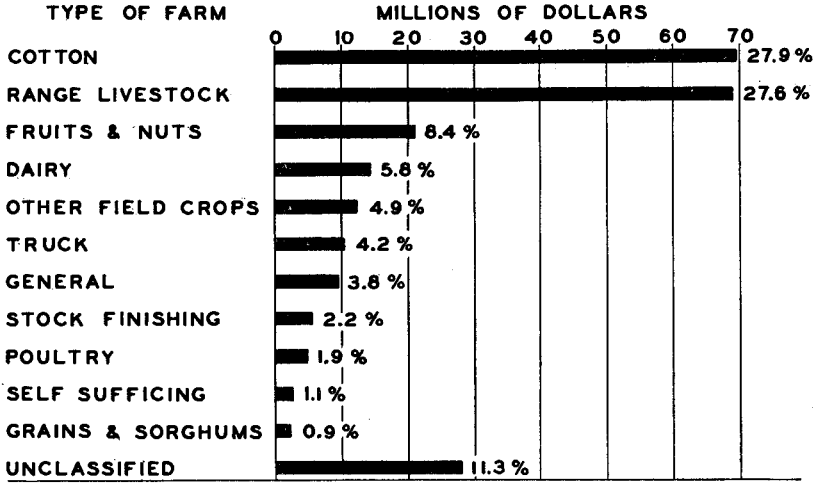

Fig. 1.—Graph showing money invested in Arizona's more important agricultural industries.

ton $17,212,500, and from range livestock (cattle, sheep, and wool) $16,195,000. Next to these should be listed the horticultural industries comprising fruit, nuts, and truck crops. The money here invested amounts to about 13 percent of the whole, or $31,178,700. Dairying, general farming, cattle feeding, and poultry raising follow on in the order named.

This bulletin is intended to give a bird's-eye view of Arizona's agriculture and of those physical factors which determine it.

CLIMATE

The city of Tucson has the distinction of starting, in 1875, the first regular weather-observation station in the State of Arizona. At the present time more than 90 observers cooperate with the United States Weather Bureau in making weather observations in various parts of the State. Various portions of the State experience different climates because of differences in altitude, latitude, and general topography. At Yuma, in the southwestern corner where the altitude is low (144 feet above sea level), high temperatures of long duration prevail, while in the north, at Flagstaff at an altitude of 6,909 feet, the summers are short and cool while the winters are long and cold. The mean maximum temperature at Flagstaff corresponds almost exactly with the mean minimum temperature at Yuma. At altitudes between Yuma and Flagstaff can be found climates of varying degrees of mildness.

A record maximum temperature of 127° for the State has been recorded at Parker, while temperatures of 120° are fairly common in midsummer along the lower Gila and Colorado River valleys. Arizona's record maximum falls 7° below the official United States maximum recorded at a ranch at the edge of Death Valley, California. Arizona's minimum temperature of — 32° does not approach the extremely low winter temperatures sometimes recorded in the northern mountainous states.

The average length of the growing season varies from 42 days at the Bright Angel Ranger Station, Grand Canyon, to 355 days at Yuma. Stations having higher altitudes than Yuma as a rule have shorter growing seasons. An increase of 45 feet in altitude, on the average, decreases the length of the growing season by one day. At the University of Arizona in Tucson the average length of the growing season is 247 days, at Phoenix 295 days, at Prescott 147 days, at Springerville 137 days, at Willcox 192 days, and at Williams 122 days. The importance of the length of growing season must not be overlooked when considering a new crop in a given community.

The average annual precipitation in the State varies from slightly over 3 inches to more than 30 inches. Only a small portion of the State, however, receives more than 20 inches. The areas of higher rainfall are located in the plateau country in northern Arizona, while those of least rainfall are found in the Lower Gila Valley. The entire northeastern part of the State receives less than 10 inches of rainfall annually. Snow is very common during the winter at altitudes of 5,000 feet or more. Rains occur at two distinct seasons in Arizona. During July, August, and September about half of the total yearly rainfall occurs. Thunder showers are common during these three months. In the winter months, particularly December, gentle rains of several days duration occur. May and June are the driest months of the year.

Destructive winds are unusual in Arizona, although occasionally wind damage to buildings and crops is reported. Wind velocities from 45 to 58 miles per hour have been reported but these are uncommon. The average wind velocity for the various Arizona stations ranges from 5 to 8 miles per hour.

The humidity in Arizona is low, particularly in the southern and sotuhwestern parts of the State. In the north where more rain falls it is somewhat higher. An average of all readings shows an annual relative humidity of approximately 40 percent. With such low humidities and with a high percentage of possible sunshine, (from 75 to 90 percent), evaporation is high. At Yuma the annual evaporation is over 120 inches and at the Mesa Experiment Farm near Phoenix it is 77 inches.

Bulletin No. 130 of the Arizona Agricultural Experiment Station gives a complete summary of all the weather observation stations in the State up to 1929.

SOILS

Less than 1 percent of the soils of Arizona are under cultivation. The reason for this is largely because of a scarcity of water, as most of the areas otherwise suitable are in districts where irrigation is necessary. Dry-farming is practiced to a limited extent in the northern part of the State.

Physiographically, Arizona may be divided into two parts: In the north, the Colorado plateau and in the south, the semi-arid desert section. The soils in one area in the north, near Winslow, have been surveyed by the United States Bureau of Soils. This area consists of 147,840 acres along the Little Colorado River that might possibly be irrigated by diversion of water from that river.

Some of the soils on the top of the mesas and rolling ridges have weathered down in place from the sedimentary rocks of the country. The greater part of the soil material has been transported from the higher ridges by water and has spread over the valleys as old alluvial fans. Other groups of soils, alluvial in nature, are found along the rivers and

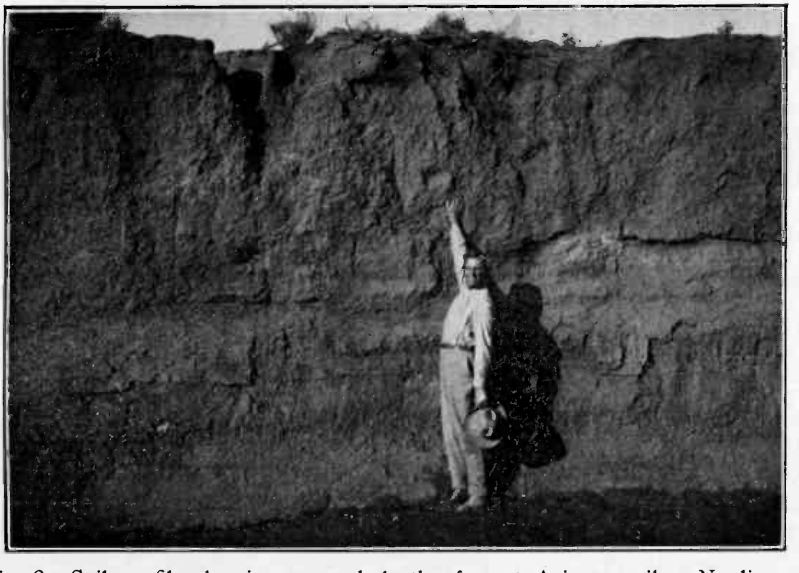

Fig. 2.—Soil profile showing unusual depth of most Arizona soils. No line of demarcation between surface and subsoil.

creeks. These are very young and have not yet developed subsoils. They are usually stratified.

In the south the same weathering agencies have been at work as in the north. Soil material has been eroded from the higher points to the valleys or have been carried down from the mountains to form intermountain plains as the alluvial fans from different directions converge. Unlike the soils in the north, most of the southern soils have developed from volcanic rocks instead of the sedimentary shales and sandstones. The soils in the intermountain plains may be classed as old alluvial fan soils if they have well developed subsoils or as recent alluvial fan soils if the subsoil material is the same as the surface soil. Soils deposited along the banks of streams which do not have well defined subsoils are classed as recent alluvial soils. These soils are rich in mineral plant food materials and contain more nitrogen than the still newer alluvial fan soils of the higher mesas, and being close to streams, can often be irrigated at low cost. The soils in the broad Salt River Valley have resulted from the weathering of the mountains on each side. The mesa soils at Yuma are the remnants of an old coastal plain and are very sandy. Silt in the irrigation water from the Colorado River has, over a period of years, materially changed the texture of certain of the Yuma soils.

Some of the older soils in the southern part of the State are underlain with a lime hardpan (caliche) which was probably formed in shallow lakes and subsequently covered with soil.

The majority of soils in Arizona contain an abundance of lime, calcium carbonate, and are consequently slightly alkaline. In the Nogales area in the extreme southern part of the State where rainfall is fairly heavy the lime has been leached away and the soils have become very slightly acid in places.

Generalizations cannot be made on soil texture as the soils vary from heavy clays to coarse sands, although the fine sands, sandy loams, and silt loams predominate.

Detailed Federal soil survey reports and maps are available for the following areas: Buckeye-Beardsley, Salt River Valley, Middle Gila Valley, Solomonville, Benson, San Simon, Winslow, Paradise Verde, and Gila Bend. Other areas which have been surveyed but on which reports have not yet been published are Nogales, Tucson, Santa Rita Range Reserve, St. Johns, and Yuma.

Arizona soils are on the whole fertile soils provided they can be made to "take water" readily and are kept reasonably well aerated by the introduction of organic matter and by proper drainage. They contain very little organic matter and nitrogen, hence manure (both animal and green) is the most common fertilizer and is used extensively.

White and black alkali salts exist in widely scattered areas over southern Arizona. The reclamation of such areas depends largely upon the subsoil, as good drainage is the first essential for leaching operations. If underlain with sand or permeable substrata the removal of such alkali can be effected without excessive cost.

IRRIGATION

With the exception of several relatively small areas in the northern part of the State which lie at high altitudes and are farmed without irrigation, all the cropped lands in Arizona require irrigation. The 1930 Federal Census shows a total of 575,590 acres, in 8,523 farms, irrigated in 1929, and that the irrigation enterprises of the State are capable now of irrigating an additional area of 248,562 acres. The irrigated area is 0.8 percent of the land area of the State. It is possible that this may be increased in the future to about 2 percent of the total area as new enterprises are developed. Eighty-seven percent of the present irrigated area is in the drainage basin of the Gila River and its tributaries, and 10 percent is irrigated directly from the Colorado River.

Water supplies for irrigation are obtained from flowing streams, or by pumping from wells, or from minor sources such as springs and artesian wells. Ephemeral flood flows are utilized in some localities. Eighteen percent of the irrigated area is irrigated from pumped wells and 51 percent additional derives a part of its supply from wells. Groundwater supplies and pump irrigation are therefore of relatively high importance in Arizona.

Rainfall in the arid Southwest is subject to wide fluctuations, and the natural flow of streams fluctuates even more than the rainfall. But great reservoirs such as those on the Salt and Gila rivers and smaller reservoirs on some of the other streams have accomplished much in equalizing the available water through the two rainy periods of the year and the intervening dry periods, and also in holding over large supplies from years of abundant rainfall for the drier years. Groundwater basins also act as reservoirs and provide constant dependable supplies if the draught on wells is properly proportioned to the recharge which these basins receive indirectly from rainfall and streams.

The irrigation enterprises include two Federal projects (the Salt River Valley and the Yuma Valley), many "districts" organized under the State reclamation district laws, a few commercial companies, and many mutual water companies. A settler should familiarize himself with the type of organization and its liabilities and his own contract.

Water is delivered by the water master to each landowner, ordinarily at the highest point of his land or reasonably near that point. From there on, the supply ditch, the field laterals, and the head ditches belong to the landowner and are built and maintained by him. These farm ditches are built usually with a "Vee," a triangular frame drawn by horses or a tractor. If the soil is loose and porous so that the percolation loss is great and if the water is costly or is applied to crops of high value, the ditches can be, and in many cases are, lined with concrete or concrete pipe conduits are used for the distributing system.

The methods of applying water vary with the crop, and to a lesser extent, with topography and soil. Row crops are irrigated in furrows between the rows. Usually field crops, including alfalfa and wheat, are flooded in long "lands" with low levees from 30 to 60 feet apart, and with a gentle fall lengthwise. On steeper slopes alfalfa is irrigated by small streams running in corrugations (small furrows) or by flooding from small field ditches. Cotton is often irrigated in furrows at the outset but after midsummer the water is practically flooded down a dozen rows at a time. Orchards are sometimes basined, one to four trees in a basin, sometimes irrigated by several furrows on each side of the tree row, and sometimes flooded in lands 330 or 660 feet long, the choice depending on the soil and other conditions.

The frequency of irrigation depends on the crop, the soil, and the season. Vegetables may require weekly irrigations, alfalfa on deep, retentive soil, one irrigation for each cutting, but on poorer soils, two or even three. Cotton fields are irrigated thoroughly before planting, sparingly or not at all for 8 or 9 weeks, and then frequently during the fruiting season.

Whatever method is to be employed, the land must be prepared with much care and with even grades so that the water can be distributed uniformly to all parts of the row or the field. Irrigation is an art; not only is the distribution important, but the quantity absorbed must meet the requirements, since sometimes 2 inches depth of water is needed, sometimes 4, and sometimes 6 inches. An excess is wasteful, and if practiced repeatedly may cause waterlogging of the land.*

The quantity applied per year is called the (annual) duty of water. Alfalfa can utilize an exceedingly large quantity, as the yield is almost in proportion to the water applied, about 1.5 tons per foot depth of water. If conditions demand it, alfalfa can be maintained with 3 acre-feet of water per acre per year, but considering the fixed charges on the

* Farmers' Bulletin No. 864, entitled "Practical information for beginners in irrigation," published by the United States Department of Agriculture is recommended, and is replete with helpful suggestions.

land such as taxes and interest, it is more profitable to use 4 or 5 acre-feet and obtain the increased yield. Upland cotton requires about 3 feet depth of water on medium soil and long-staple cotton, with a longer growing season, about 3.5 feet. Wheat, barley, sorghum, and corn require each about 2 feet; if the land is double-cropped, say with wheat followed by sorghum, 4 feet depth of water is needed. Cantaloupes and fall lettuce require 2 feet each, and spring lettuce somewhat more unless favored by heavy winter rains. Mature citrus orchards can utilize 3 or 4 feet depth and if a cover crop is planted in winter or summer, 1.5 or 2 feet more. An average for the diversified agriculture of the Salt River Valley is about 3.5 feet depth, to which must be added the canal losses from the river to the points of delivery.

Variations from the usual irrigation practice are common. For example, the soil of the Yuma Mesa is more porous than that of the Yuma Valley or the average Salt River Valley soil, and therefore irrigations must be lighter and more frequent. In some areas where the good retentive soil is deep and where no storage reservoirs have been built, enough water can be stored in the soil by heavy winter irrigations to raise two crops of alfalfa or to carry deciduous orchards through the dry season.

The cost of irrigation water varies with a great many factors. In the year 1932 some Arizona farmers are using water which is costing them over $10 per acre-foot, while others are securing water at 20 cents an acre-foot. This cost should be ascertained beforehand by the prospective purchaser of land. In each case, whether it be a gravity or a pumped supply, the fixed charges and operating costs must be determined from the circumstances. It should be borne in mind that, if two farms are otherwise equal but have different sources of water, the purchaser of the cheaper farm can afford to pay $7 or $8 more per acre each year for his water supply as an offset to his saving in interest charge.

FIELD CROPS

According to the 1930 United States Census, there are in Arizona approximately 663,000 acres * of cropped land of which 478,223 were devoted to harvested crops. While this ranks Arizona among the lowest one-third of the states in cropped land, the acre value of the land is high, the State ranking fourth. From the above acreage, during the 5-year period 1927-31, crops (including grapefruit, oranges, cantaloupes, and lettuce) were produced having an average annual farm value of approximately $34,640,000, or a gross return of slightly more than $70 per acre.

* This acreage includes both irrigated and non-irrigated lands.

The production of crops on non-irrigated land is a common practice in some of the higher mountain valleys in northern Arizona where rainfall is fairly certain and ample. The main crops produced under such conditions are corn, the small grains, and beans. Corn, wheat, and beans are produced quite extensively by the various Indian tribes on summer and winter rainfall. The diversion and utilization of flood waters permit crop production on areas on which the moisture would be deficient otherwise. The storage of water in small " repressos " for irrigation purposes is receiving attention in different parts of the State.

Dry-farming as it is practiced throughout the Great Plains area is not of very great importance in this State due to the uncertainty of rainfall, the high rate of evaporation and the fact that the subsoils in many sections are rather non-retentive of moisture. Improved cultural practices would permit some increase in non-irrigation farming at many of the higher elevations.

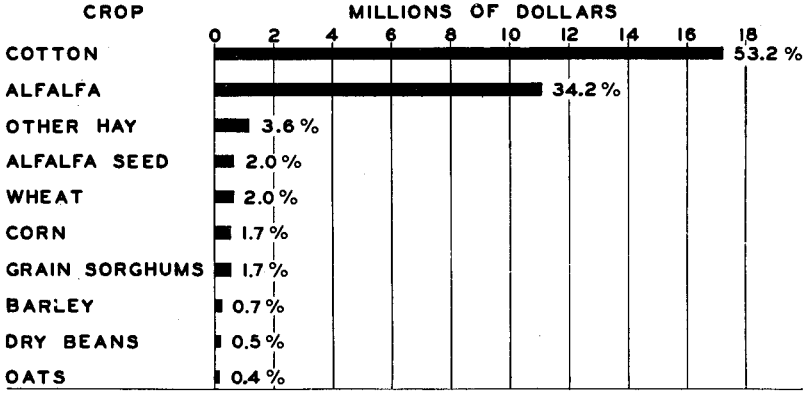

Fig. 3.—Graph showing 1929 gross farm incomes received for the more important field crops grown in Arizona.

Irrigation, however, is the key to successful farming in most sections of the State. Largely from the irrigated acres during the 4-year, period 1928-31, cotton, alfalfa (for hay), grain sorghums, corn, wheat, and " other tame hays " have occupied the major portion of the cropped areas. From these six crops, farmers of the State have realized more than 77 percent of their total crop income. Cotton has been grown on approximately 204,000 acres annually which have produced nearly 145,000 bales, or roughly 1 percent of the total United States crop. This one crop has contributed almost 40 percent of the total crop income of the State every year during this period. While cotton prices were good,

acre yields averaging around three-fourths of a bale brought excellent returns in spite of high production costs. Unprecedented low prices for the 1931 crop have caused many growers to switch from high-cost cotton to lower-cost feed crops during the 1932 season. Long and short staple cotton are both grown successfully in Arizona. Varying acre-returns during the past few years have caused shifts from one staple type to the other. The long staple American-Egyptian-Pima cotton and the Acala and Mebane varieties of the Upland type are the ones most commonly planted. Arizona Upland cottons are noted for their white color and extra length of fiber. Rather stringent quarantine measures have held at a minimum the insect and disease problem. Given moderate prices, therefore, the main problems in profitable cotton production in Arizona are tied up with the efficient and proper use of water in producing cotton of uniform staple, a quality desirable to the mills of the east where the crop is utilized.

Alfalfa hay and other tame hays have occupied some 22.5 percent of the crop acreage during the 1928-31 period, and from these crops has come almost 28 percent of the farm-crop income. The average yield of alfalfa for the State has been just below 4 tons per acre. More than 470,000 tons are produced annually (1928-31), of which considerable quantities are shipped to consuming areas outside the State. The Chilean and Hairy Peruvian varieties are those commonly grown. Emphasis is placed upon the production of the better grades of hay in order to meet market demands.

Considerable acreages of alfalfa are utilized for pasturing cattle and sheep, both in winter and summer, thus supplementing native grass ranges and serving as insurance during dry seasons.

Excellent yields of high quality alfalfa seed are obtained in the Yuma and Salt River valleys. Alfalfa-seed production has had an important place especially in the Yuma Valley and is well suited to the general farming practices of that area. The maintenance of high yields and the production of the kinds of seed demanded by the market are receiving attention.

The grain-sorghum acreage, while showing a marked decline from 52,000 acres in 1928 to 24,000 acres in 1931, shows a marked increase in 1932. Hegari is the most important variety grown and is well suited to the production of grain and silage in the main irrigated valleys of southern Arizona. The small amount of seed required, short growing season, low water needs, and minimum of labor required coupled with high yields of grain and forage, make this crop very popular in times of low prices. Changes and improvement in the methods of handling the

grain-sorghum crops together with their very important place in the local feeding and fattening of livestock, insure their continued important place in the cropping system of the State.

Corn is grown in scattered areas throughout the State by both white and Indian farmers. It does its best for grain at the higher elevations, especially where the soil is fertile and where there is considrable summer rainfall or where irrigation water is occasionally available. The annual crop of around 800,000 bushels is grown on a little more than 5 percent of the cropped land and provides 3.3 percent of the farm-crop income. The white Mexican June variety is most commonly grown in the southern valleys but varieties adapted to the very different conditions of the State are not yet well determined, and insect and disease control work merit attention. The corn produced is used largely for food by the Indians and for poultry and dairy feed by all farmers. At the present time considerable amounts of yellow corn are brought into Arizona from states to the east and north for poultry feeding.

Wheat, the principal small grain grown, like corn, is rather general but scattered in the distribution over the State. Somewhat fewer acres are devoted to producing wheat than to corn, but the number of bushels, averaging 758,000 for the 1928-31 period, and percent of total farm income are slightly higher for wheat. In the southern part of the State spring varieties are grown most, and are sown in the late fall and winter. At the lower elevations, soft white wheats such as Early Baart are most common. At higher elevations in the north central and eastern parts of the State, the Marquis and Defiance varieties are commonly grown. Climatic conditions during the fall make the general use of winter wheats impractical. When uncontrolled, rusts, smut, and insects do considerable damage to small grains in Arizona. The wheat produced is used by local mills, many of which import hard red wheats from Colorado, Kansas, and elsewhere to blend with the soft wheats in making desired grades of flour.

Oats and barley are grown for grain to a limited extent, but all the mentioned small grains find a fairly extensive use as hay crops, especially where alfalfa is not well adapted. Oats and barley for grain together annually occupy about 25,000 acres and produce only slightly more than 2 percent of the total crop income.

Potatoes and beans are minor crops grown in a more or less limited manner throughout the State for local consumption. Although occupying a small portion of the crop acreage, they form an important item of food for local consumption.

SEED GROWING

Experience has shown that wherever crops are grown, an adequate, continuous pure-seed supply of adapted strains and varieties is absolutely necessary for high production and uniform quality. The seed supply, however, has not always received the attention it deserves among those responsible for our agricultural programs. It is also certain that this is not due to any difficulty connected with the actual field production of proper seed. The climatic conditions of most of the agricultural districts of Arizona are particularly favorable for the production of seed of a large number of crops. The light rainfall, the mild climate, and the control of moisture through irrigation make the seed crop a practical certainty. Furthermore, the seed produced under these conditions is usually of the highest quality, being free from weathering, and also highly viable. For these and other reasons it seems probable that commercial seed production in Arizona will greatly increase once these advantages are understood and appreciated. At present, however, there seems to be a need in the State for a number of commercial seed growers possessing the requisite knowledge and experience for producing seed of dependable quality. Such seed growers are of value not only in providing seed in sufficient quantities for home planting, but they are often

Fig. 4.—View of wheat-breeding plots at the Yuma Valley Sub-station.

the means by which the seed of improved strains and varieties are kept pure and available to the public at large.

During the past several years the Arizona Agricultural Experiment Station has bred up and distributed, from time to time, improved strains of alfalfa, wheat, cotton, and grain sorghums. Seeds of additional strains of these crops as well as of others will be available in the future, since crop breeding is one of the major lines of work at this Station. Yet the seed of those strains which have been distributed in the past to the general grower have not always been kept pure, mostly because it is nobody's business to increase the small lots of seed which the Station has supplied. It is not possible for the Station to produce, at most, more than a few hundred pounds of seed of its improved strains. If this seed is distributed to each of several farmers, there is small probability that it will be increased in sufficient quantities and with the required purity for general utilization in those regions of the State to which it is adapted. If, however, all the seed of a given strain from the Station could be turned over to an experienced, well-equipped seed grower, it could be increased with such supervision and handling as to insure maintenance of identity.

There are many reasons why the general grower can not be expected to take a small amount of pure seed, be responsible for its increase, and at the same time maintain its original purity. Cross pollination from adjacent fields of inferior or different varieties of the same crop, and mechanical mixing of the seed with other varieties in custom gins, threshers, and recleaners, may greatly impair the value of the new strain in 1 or 2 years. The seed grower, however, can be held strictly responsible for providing all of the necessary conditions for keeping the seed pure which he produces, so that the association within which he works, and the public in general will be assured of pure seed of high quality. This would also make possible greater utilization of the improved strains bred up by the Arizona Experiment Station, and thus increase the usefulness of the Station's plant breeding work to the farmers of the State.

HORTICULTURE

A wide variety of horticultural crops is grown in Arizona. Commercial production of these is confined almost entirely to the irrigated valleys in the southern part of the State. In other parts of Arizona, many fruits and vegetables are grown satisfactorily for local market and for home use. The estimated total investment in commercial orchards in Arizona including 1932 plantings is $25,275,000. Citrus development comprises 87 percent of this with pecans 5 percent, deciduous fruits 4

percent, dates 2.5 percent and others 1.5 percent. The total investment in the most important truck crop enterprises is $10,134,725 of which 60 percent is in lettuce, 25 percent in cantaloupes, 4 percent in watermelons with minor crops comprising the remainder. The farm value of these crops, as reported in the 1930 Federal Census, is shown in Figure 5.

The European grape is grown extensively in home vineyards in the lower valleys of the State. In the Salt River Valley, a number of vineyards of considerable acreage are producing early table grapes of excellent quality for carlot shipment to eastern markets. American varieties of grapes are being grown successfully in home vineyards at elevations of more than 4,000 feet.

Oranges and grapefruit of excellent quality and early maturity are produced in the Salt River Valley and on the Yuma Mesa. Some 20,000 acres have thus far been planted to these fruits. Dates are being planted more extensively each year. The choicest of Persian Gulf and North African varieties have been introduced and offshoots of many of these are available for commercial plantings. While the cost of establishing a date garden is greater than for most any other orchard fruit, returns are correspondingly greater.

Some 4,000 acres of the lower irrigated valley lands have been planted to improved varieties of pecans. A high-quality, large-sized nut is being grown and production of the groves now in bearing appears to be significantly greater than in the older established pecan districts of the southeastern states. Plantings thus far have been confined largely to the Yuma Valley, but many acres of deep, fertile soil in the Gila, Salt, Verde, and Santa Cruz valleys appear to be well suited to the crop. Small acreages have been planted in these areas.

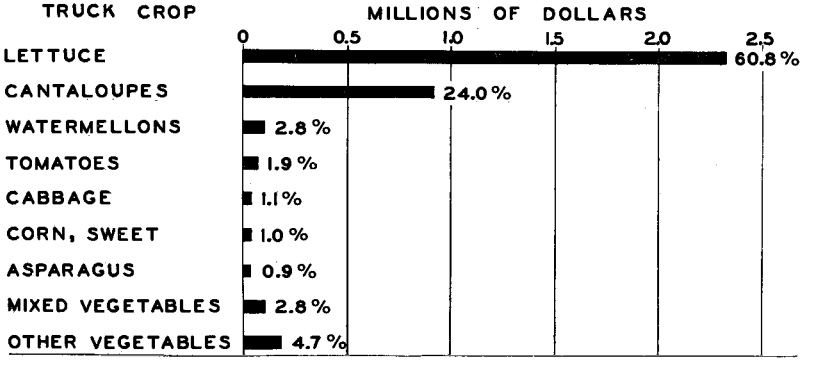

Fig. 5.—Graph showing 1929 gross farm incomes received for the more important truck crops grown in Arizona.

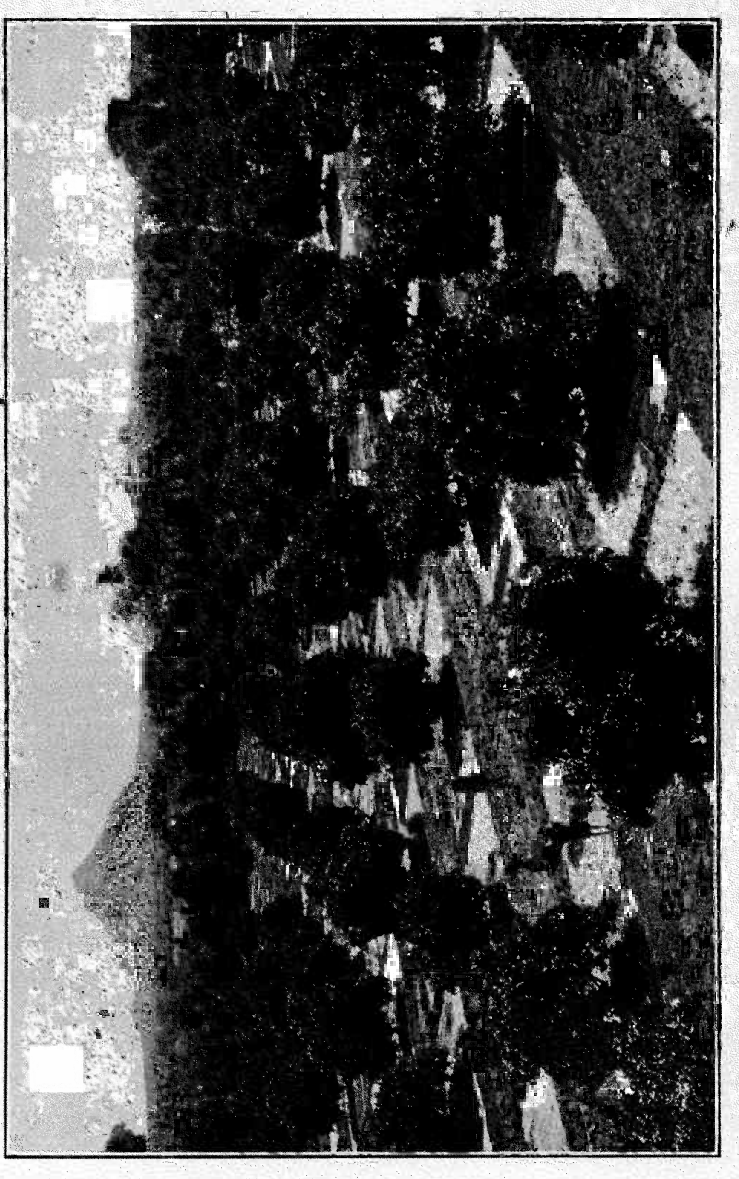

Fig. 6.—Typical citrus grove in Salt River Valley.

Fig. 7.—Bearing pecan grove in Yuma Valley.

The major truck crops produced in the State are cantaloupes and winter head lettuce. Several thousand cars of each are shipped annually, chiefly from the Salt River and Yuma valleys. While production in certain districts may be reduced some years by climatic hazards, returns depend mainly upon fitting the Arizona crop into the production program of the other large producing areas of the Southwest. Arizona's lettuce crop is in two deals, one planted to precede the Imperial Valley (California) crop and the other to follow it. The cantaloupe deal follows the peak of the Imperial Valley crop. Several deals of both crops have failed to return a profit during the past 5 years.

Other truck crops produced commercially to some extent in the irrigated valleys are asparagus, peas, white potatoes, sweet potatoes, carrots, and watermelons.

Of the small fruits, strawberries and blackberries are grown in limited quantity for markets within the State.

Apples, pears, and peaches of excellent quality are grown for market in many of the higher, irrigated mountain valleys of northern Arizona. Apricots, Japanese plums, and peaches succeed well in the lower irrigated valleys.

Orchard fruits and vegetable crops are grown for home use in practically all parts of the State where farming operations are at all practicable. At the lower elevations the hardy group of vegetables are grown during the fall, winter, and spring months and many subtropical fruits may be planted in the home orchard. At higher elevations, vege-

table production is confined to the spring, summer, and fall months and the temperate zone fruits must be grown.

PLANT DISEASES

The term " plant disease " as here used includes diseases of the higher plants which are caused by parasitic fungi, bacteria, and flowering hemiparasites such as dodder and mistletoe; virus diseases such as the curly top of beet; physiological diseases like the corrosion of roots in alkali soil, injury by frost and drought, strangulation of roots in waterlogged soil, and other diseases caused by unfavorable environmental conditions; and root knot caused by nematodes. Many diseases of plants prevalent in other states are absent or unimportant in Arizona. Among these may be cited anthracnose and Fusarium wilt of cotton, brown rot of stone fruits, black rot of grapes, the various down mildews, clubroot of cabbage, Nectria canker and black knot of fruit trees, and late blight of potatoes.

On the other hand, one fungal disease which is limited to Texas and the Southwest attacks numerous host plants and causes a heavy annual loss. This disease is Texas root rot caused by *Phymatotrichum omnivorum*. Among other plant diseases found in the State are crowngall (*Phytomonas tumefaciens*), various rusts and smuts, powdery mildews, the true rust of cotton (*Aecidium gossypii*), rust of beans (*Uromyces appendiculatus*), Fusarium wilt of watermelons (*Fusarium niveum*), bacterial slime of lettuce, lettuce drop (*Sclerotinia sclerotiorum*); rhizoctoniose of cotton, potatoes, beans, peas, and other plants; wilt of chili (*Fusarium annuum*), virus diseases of the potato; canker of poplar, walnut, willow, pecan, apple (*Cytospora spp.*); brown-rot gummosis, scaly bark, and other diseases of citrus; several diseases of the date palm, and root knot (*Caconema radicicola*) on many kinds of plants.

Among plant diseases some are general and others are limited to a few host plants, in some cases to a single species. The worst general disease in Arizona is Texas root rot. This disease attacks several hundred species of plants including trees, shrubs, and herbs. Furthermore, the causal fungus can exist in the soil for an indefinite period. Pathologists have shown that the fungus in the soil can be killed by strong disinfectants and possibly by drying out the soil over a 1- or 2-year period. However, the cost of cleaning the soil is heavy after the fungus has gained a foothold. The time to combat the root rot is when the first small spot of infection appears in a field.

Crowngall is another general disease, although it attacks fewer plants

than Texas root rot. The disease is sometimes brought into fields on nursery stock; in other cases it appears to be indigenous on wild plants. Once a plant becomes infected there is no cure. The disease is practically always fatal in the dry, hot climate of Arizona where the intake and outgo of water in plants are so nearly balanced. Soil that is free from the crowngall bacterium should be kept so, for the organism, once introduced into the soil, may remain alive there for more than a year. Rooted plants should be inspected for galls before they are transplanted into clean soil. The practice of sowing grain for the first and second years on land newly cleared of mesquite and other wild plants is advisable in order to give time for possible natural infection to die out.

Sclerotiniose is a general disease on beans, lettuce, potato, carrot, cabbage, kale, cauliflower, tomato, cucumber, and onion, although it has so far caused serious loss in Arizona only in lettuce fields. Rotation with immune crops appears to be the most practical method for the control of the disease. Rhizoctoniose, known as sore shin on cotton and black scurf on potatoes, also attacks beets, carrots, radishes, lettuce, onions, tomatoes, beans, and peas. In this State important losses attributed to *Rhizoctonia solani* have been confined to cotton, potatoes, beans, peas, and strawberry plants. Another species of Rhizoctonia, *R. violacea,* attacks alfalfa and sweet potatoes in Arizona.

Root knot caused by a small roundworm, *Caconema radicicola,* is increasing in importance not only in Arizona but also in other states. For this disease many hosts have been listed. Among the plants attacked by root knot in Arizona are the fig, peach, willow, Washington palm, grape, rose, okra, iris, watermelon, squash, cantaloupe, beet, lettuce, onion, and many other plants. The root-knot nematode is commonly carried in soil and by transplanting rooted plants. For this reason it is safer to plant seeds whenever possible rather than to purchase tomato, cabbage and other seedlings for planting. Nursery stock should undergo careful inspection for knots on the roots before such stock is set in clean soil. Nematodes are eradicated only with considerable expense, therefore an effort should be made to prevent their introduction and dissemination. Another nematode, *Tylenchus semipenetrans,* which attacks the roots of citrus trees, is also found in a limited area in Arizona.

Rusts of cereals, more strictly limited in their host relations, are perhaps best controlled by using resistant varieties. Work on the development of such varieties is progressing in several experiment stations of the United States. In the meantime, dusting with sulphur has been found to reduce stem rust of wheat. Bunt or stinking smut of wheat, although it is easily controlled by the use of copper carbonate dust on the seed, is more abundant in Arizona than it should be. Loose smuts

of barley and wheat are controlled by using the hot-water treatment of the seed; covered smut of barley and oats and loose smut of oats may be controlled by treating the seed with formaldehyde solution. These diseases of cereals, as well as smuts of corn and sorghums, occur in Arizona.

Space does not permit the mention of less important diseases which appear in the State. However, those interested in plant diseases in Arizona and desirous of obtaining more detailed information on the subject are invited to correspond with the Department of Plant Pathology of the Agricultural Experiment Station.

INSECT PESTS

The Department of Entomology and Economic Zoology carries on investigations of insect pests and offers advice concerning their control. The Arizona Commission of Agriculture and Horticulture has for many years maintained an inspection system to prevent entrance into the State of injurious insects not native or not already present. As a result some of our major horticultural crops are not handicapped by many injurious insects. Olive orchards are clean and free of the numerous injurious scale insects prevalent elsewhere. The citrus industry is free from most of the major insect pests of that crop. The citrus thrips is present, and is sometimes injurious, especially to oranges, while at other times its damage is negligible.

The grape leafhopper is always present and sometimes does very serious injury to grapes, and the grape leaf skeletonizer occasionally is injurious, but is readily controlled. Other grape pests are absent or of minor importance.

The tender succulence of lettuce subjects it to the ravages of a number of insects in a minor way, one or more of these occasionally becoming of major importance locally. The most serious single pest of lettuce is the salt marsh caterpillar, which is quite capable of wiping out whole fields of young lettuce in the autumn.

Cotton is attacked by a multitude of insects, some of which at times reach pest proportions, but the industry is, up to the present, happily free from the Mexican boll weevil menace. Certain local infestations of the pink boll worm have occurred, but these are believed to have been wiped out by cooperation of the State and Federal forces, as in several other such cases in other cotton-producing states.

The chief pest of melons, as elsewhere, is the melon aphis; this crop not being in a much more favorable position here than elsewhere as regards injurious insects.

While, as indicated, Arizona is free from a number of major insect pests, especially of horticultural crops, one undertaking agriculture here must not expect freedom from insect pests in general, either on account of the heat, or the dry atmosphere. Certain major pests are absent, it is true, but there is a host of other, ofttimes minor, pests, which give the farmers sufficient concern. A mere list of the pests recorded would occupy more space than could be allotted within the limits of this bulletin.

Since considerable honey of an excellent quality is produced in Arizona, a statement of the possibilities of beekeeping may not be amiss.

BEEKEEPING

Arizona, especially the southern portion, offers to beekeepers certain advantages, such as a long season and freedom from the problem of winter packing. It also offers considerable opportunity for expansion of the industry, as will be indicated. The average annual production of honey in the State has been estimated at about 900,000 pounds, or 450 tons. Some enthusiastic beekeepers have estimated that this amount might be increased ten-fold, or to a total production of 4,500 tons per year, partly by the use of better methods of beekeeping, but largely through the expansion of the industry to occupy the area more fully and conserve the nectar now going to waste. Large areas offering good locations for apiaries are unoccupied; others are only partially occupied. In some of these there is the disadvantage of remoteness from market, but with the present development of the automobile and the rapid increase in good roads, the extent of available bee-pasturage is much enlarged. A concentrated, high-priced, non-perishable product such as extracted honey in 60-pound cans or friction-top pails may profitably be hauled a much greater distance to market than most other agricultural products.

The most important native honey plants are the trees or shrubs known as mesquite (*Prosopis velutina*) and catsclaw (*Acacia greggii*). In locating an apiary one should seek the valleys and washes from mountain canyons where these plants grow most abundantly, forming as they do dense thickets where not cleared. There are two common catsclaws, but only the one above mentioned is of value as a source of nectar. The other, *Acacia constricta,* bearing an abundance of bright yellow ball-like flowers in both spring and summer, yields no nectar. A wide variety of native wild flowers usually furnishes an early spring flow of nectar sufficient for daily consumption and brood-rearing, and occasionally a small surplus in the most favorable years. The dry mesas, covered with creosote-bush, widely but erroneously known as "greasewood," are not fav-

orable locations, as this plant yields but little nectar and the honey is of poor quality, strong, and dark. Mesquite and catsclaw blossom almost simultaneously in April, May, or June, according to altitude. They are reputed to bloom again, producing a second flow in the July-August rainy season, but in several years' observation the author has failed to note either an abundance of bloom or an important honey-flow. In the Salt River Valley, cotton and alfalfa honey are produced although the region about Yuma produces more of the latter since it is an alfalfa-seed-producing region. Alfalfa in the arid Southwest when cut for hay is mowed before any considerable blossoming occurs. Sweet-clover growing is in its infancy, but may offer lucrative possibilities to the Arizona beekeeper where there is irrigation. Sweet-clover honey as garnered by the bees from the University farm near Tucson, however, was of disappointingly strong flavor and amber color.

As in any other locality, some seasons are much better than others, though complete failures are rare. An average production of 80 pounds per colony has been estimated, but probably 50 to 60 pounds is a safer estimate. Nevertheless, in the best seasons those beekeepers who use the most modern methods can secure as much as 100 pounds per colony.

It should be stated that all the estimates offered above are with reference to extracted honey production. This region is not well adapted to the commercial production of comb honey, although some fine comb honey is at times secured. A small amount of chunk honey is produced and marketed locally. Some of the more important sections of the State not now well stocked with bees are the Santa Cruz and Rillito valleys and Pantano Wash, and their tributaries, in Pima and Santa Cruz counties; the San Pedro Valley in Cochise and Pinal counties — stocked in the Benson and St. David sections, but not elsewhere to any extent; the upper Gila Valley, incompletely occupied in Pinal, Graham, and Greenlee counties. A great area along the Colorado River from Needles to the Yuma irrigation project would yield quantities of honey, but has the disadvantage of remoteness from market. The Salt River Valley irrigation project is rather well stocked, but still offers some good locations in outlying districts and along the Hassayampa River as at Wickenburg.

There are probably also untouched possibilities in the northern and higher regions of the State, but the seasons are shorter and the wintering problem enters. Beekeeping will succeed in many places there, but it will require much better methods and a thorough knowledge of local conditions to secure adequate returns.

The individual who is already a master in the art of honey production

elsewhere can soon adapt his methods to the semi-arid conditions here, as we have personally observed. The one already familiar with these conditions can learn beekeeping by starting cautiously in a small way. But Arizona is not a place for the novice in desert life and in bee culture to set out to make a living from bees.

ECONOMIC NATIVE PLANTS

Arizona is an extremely diversified country, including high mountains and foothills, plains and prairie lands, river valleys and semi-desert sands, varying in altitude from 150 to over 12,000 feet. It has a scanty rainfall ranging from 3 inches on the lower desert areas to about 30 inches in the higher mountains. There are two rainy seasons, a winter and a summer. The winter climate is mild except at the highest altitudes, and below 5,500 feet elevation the summers are hot. One finds many soil types even in the same community and the plant life changes rapidly from the lower to the higher elevations.

Due to these conditions, there are to be found within the boundaries of the State more than 3,300 species of native flowering plants representing 130 families. More than a hundred kinds of trees are native to Arizona; the more important groups of these are the pines, firs, spruces, junipers, and cypresses; also oaks, alders, hackberries, cottonwoods, and willow; likewise mesquites, ash trees, box elders, maples, cherries, locusts, and elderberries. In addition to the foregoing, each of the following is represented by one species: Walnut, birch, Arizona hophorn bean, aspen, desert ironwood, sycamore, arbutus, screw bean, desert willow, western redbud, mountain mahogany, smoke tree, soapberry, desert palm, Joshua tree, palmilla, and mountain ironwood.

The largest yellow-pine forests in the world are in northern Arizona and from these millions of feet of lumber are cut annually. Flagstaff, Williams, and McNary have large sawmills. From the various species of piñons and bellota, an evergreen oak, Indians and Mexicans gather annually large quantities of nuts for the market.

More than 600 kinds of shrubs, exclusive of the cacti, are native to Arizona. Many of these are unique desert growths; some are very spiny; others, attractive evergreens blossoming at different seasons on the desert, mesas, and in the mountains. Still others are excellent browse plants supplying considerable forage that stock graze when there is a shortage of grass and other feed on the ranges. Where these grow in grass lands or in adjacent foothills the stockman has a diversified range that provides feed practically throughout the year. The more val-

uable of these are jojobe or southwestern boxwood, purple sage (*Krameria*) of desert areas and foothills, the well known sage brush of the plains, desert honeysuckle, desert ragweed, bee sage, and bladder sage; also alkali and pale squawbushes, shadscale, chamisso, lens-seeded, many-seeded and Mexican saltbushes, winter-fat and greasewood; also Apache plume; Mexican cliff rose, mountain mahogany or deer browse, service berry, scrub oak; golden currant, desert buckwheat; mock orange (*Fendlera*), blue and green canutillo or Mormon tea, scrub mesquite, catsclaw, and huajilla or fairy duster.

A number of shrubs are unique because of their showy flowers, leafless stems, pronounced spines, strong odors or other characteristics; these include creosote bush or hedeondillo, gray thorn or desert buckthorn, crown-of-thorns or allthorn, junco, garambullo, desert broom, huisache, desert senna, and mimosas and acacias.

The cactus family is represented in our flora by nearly a hundred kinds, including the lordly giant cactus, or sahuaro, which attains a height of 35 to 50 feet, pitahaya, or organ pipe cactus, and senita, or old man; the two latter found only in our warmest canyons and foothills, reina-de-noche or night-blooming cereus, also chollas or cane cacti, prickly pears, hedgehog or strawberry cacti, barrel cacti, or bisnagas, and dainty pincushion cacti of many kinds. Perhaps greater interest is manifest today in cacti than in any other group of plants on account of their unique growth, symmetrical shapes and beautiful blossoms. The Southwest is one of the world's most important cactus gardens. For many years the University of Arizona has given much time to the study of cacti, including their identification, preservation, and culture.

The chollas and prickly pears supply considerable succulence in the form of roughage for stock, which is much in demand when there is a shortage of feed on the ranges. The fruit of certain chollas remains unchanged on the plants for years and is relished by stock; when singed with a torch, the joints also are eaten. Cactus forage is of low nutritive value; it is high in salts and water content and hence stock drink less water when eating it, and low in fats and nitrogen. When taken with other more nutritious feeds it acts as a regulator and promotes the health of stock.

There are nearly 300 grasses in Arizona, perhaps a larger list than can be found in any other state. Practically all of these are grazed and many are excellent pasture and hay plants. They grow mostly as bunch grasses and the number of bunches on a given area is directly proportional to the rainfall or water content of the soil. The grasses of southern Arizona are mostly of Mexican origin as our southern prairies

are a part of the northern Mexican grass flora. The grasses of northern Arizona, on the other hand, are largely species common to the northern and central states. The more important groups of Arizona grasses are the bluestem, dropseed, panic, Muhlenberg, triple-awn, brome, fescue, wheat, and grama grasses.

The grama grasses are our most valuable grazing plants and some are cut for hay. More than a dozen kinds are native to our ranges and they are valued highly by stockmen because they withstand grazing well, make rapid recovery following droughty periods, and produce a good quality of forage that cures naturally on the ranges without being harvested as hay. To these may also be added curly mesquite or southwestern buffalo grass which thrives and multiplies on the range even with close grazing. Grasses grow in all parts of the State, but they are most abundant and most valuable as feed between the altitudes of 3,500 feet and 6,000 feet where under favorable conditions they afford all-year-round grazing. Below elevations of 3,500 feet the rainfall is too scant for a good growth of grasses and hence they occur as scattered bunches; above altitudes of 6,000 feet the grazing season is relatively short on account of the shorter summers.

Another group of plants, represented by more than 300 species, are the annuals, many of which are valuable for forage during their period of growth and seed production. There are two classes of these; namely, winter annuals which begin growth in the fall or winter season and come to maturity in spring after a growth of 3 to 5 months; and summer annuals which grow only during the hot, moist season and complete their life cycle within 1 to 3 months.

Winter annuals make slow growth during the colder weather but, beginning with the warm spring days, they shoot up rapidly and provide a large amount of succulent feed on the desert within a short time. They dry quickly with the close of the winter rainy season. They include such plants as alfilaria, also called red-stem filaree, Texas filaree, several species of Indian wheat, numerous borages including stickseed, combseed popcorn flowers, stinging or golden borage, nievitas, patota or Indian spinach, purple paint brush, copa delor or golden poppy, bladder pod, species of phacelia and several annual grasses. Filaree is perhaps more widely spread and more abundant than any native annual plant. It tolerates close grazing by sheep and goats which animals are largely responsible for its wide distribution. The borages number about 50 species and are bland succulent herbs relished by all classes of stock. Their seeds are oily and very fattening. Patota is the most common annual in heavy alkaline soils in the spring and is an excellent forage. It is also eaten as greens by humans.

The summer annuals are represented by numerous six-weeks grasses, so called because of their quick growth; also by fingergrass, water or everlasting grass, several kinds of love grasses, and such other plants as golden caltrop, bledo or careless weed, alkali purslane, common purslane, morning glories and numerous species of Boerhaavia.

THE LIVESTOCK INDUSTRY

Approximately 88 percent of Arizona's acreage or about 64 million acres, is used almost exclusively as range for livestock. In addition, some five million acres that are of primary value as timber land have a secondary value for grazing purposes. With the exception of these timber areas and the comparatively small irrigated valleys, the ranges of Arizona are adapted almost solely to the production of native forages. Field-crop production in the State is definitely limited by topography and low rainfall. Range forages are a most valuable crop, and livestock is used as the means of harvesting it and converting it into market products. Thus the range livestock industry is, and will always be, of very great importance to Arizona.

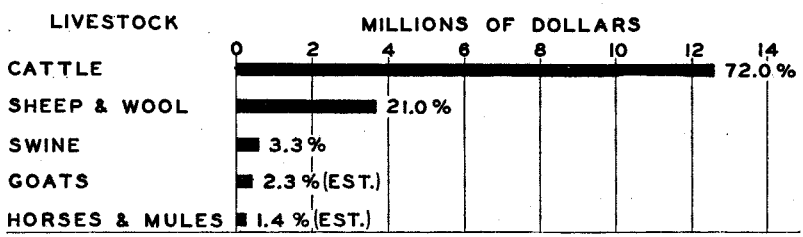

Fig. 8.—Graph showing 1929 gross returns from livestock grown in Arizona.

The topographical and climatic conditions account for a variety of range types and for the occasional overlapping of these types within the same area. The ranges may be loosely classified as the desert or lower mesa, the foothills, and the mountain types. An examination of Figure 9 gives a conception of the distribution of these range types. The areas are not absolutely definite as more than one type may occur within the same area, depending upon the altitude and resulting climatic differences. The vegetation of the desert or lower mesa ranges, located in the southern, western, and central parts of the State, is characterized by the creosote bush and associated drought-resistant shrubs, and short-lived annuals. Mesquite, saltbush, filaree, Indian wheat, and many other plants here serve as forage for livestock. The rainfall and grazing seasons are per-

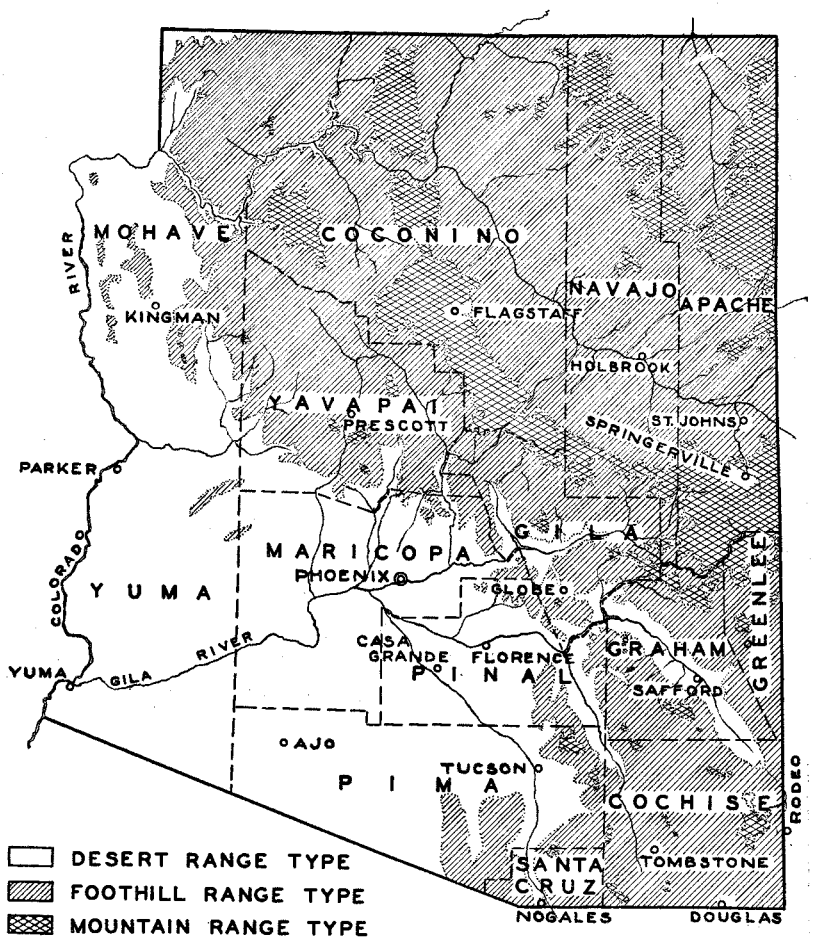

Fig. 9.—Map showing areas of different types of grazing ranges in Arizona.

iodic and the carrying capacity of these ranges is low. The foothill ranges afford all-year-round grazing. They are located in the southeastern, south central and northern parts of Arizona. These ranges begin at an elevation of 3,000 to 3,500 feet and occur up to approximately 6,500 feet. They show a great variety of plant growth consisting of grasses, shrubs, and trees, with the perennial grasses predominating. The annual precipitation on these ranges varies from 12 to 20 inches and the evaporation and water run-off is less than on the lower mesa ranges. Several types of grasslands are included under this classification. The grama grasses and curly mesquite are perennial grasses which occur here in abundance

and which are especially valuable as forage for livestock. The carrying capacity is higher than on the lower mesa range. From 20 to 40 acres are required per animal unit. The mountain or summer ranges of the State occur at elevations of 6,500 feet and higher. Mountain peaks, grassy slopes, forests, and broken rocky areas with thick, scrubby plant growth are characteristic of this type of range. Perennial grasses and browse shrubs afford summer grazing for large numbers of cattle and sheep. The National Forests include the major portion of this range type.

Approximately 30 percent of Arizona range lands are included in the Indian Reservations, 26 percent in the Public Domain, 16 percent in National Forests, and 1 percent in National Monuments and Military Reservations, thus placing about 73 percent of the land area of the State under Federal Government control. In addition, approximately 9 percent of the total area is in the form of public State lands. It is estimated that the amount of taxable land in the State is only from 10 to 12 percent of the total land area, while less than 1 percent is under irrigation at the present time.

Arizona is predominantly a range cattle and sheep producing country. The average January 1-number of animals in the State for the period 1925-29, in round numbers, is 788,200 head of cattle, 1,171,000 sheep, 91,250 goats, 18,600 hogs, and 113,400 horses, mules, and burros.

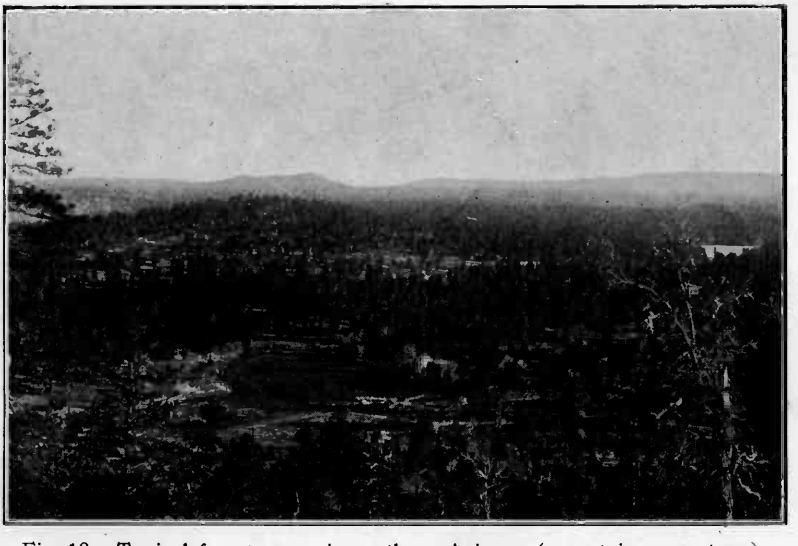

Fig. 10.—Typical forest range in northern Arizona (mountain range type).

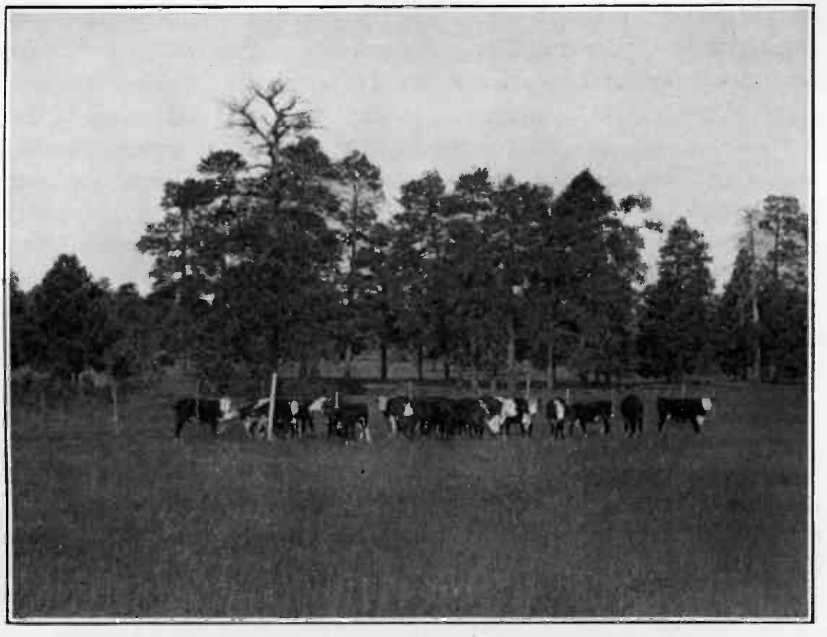

Fig. 11.—White-faced steers on Arizona range.

CATTLE

The Hereford breed of cattle is used almost exclusively in Arizona. The ranch units vary in size from those running only 200 breeding cows to those using 2,500 or more breeding cows. The ranches are for the most part under fence and may contain privately owned land, State leased land, and Federally controlled areas (either Public Domain or National Forest or both), under lease. Yearling steers, cows, and calves (in the order listed) are the principal market classes of cattle. Some are marketed as grass fat cattle, some as feeders, and a few as fed cattle after a finishing period in the irrigated valleys. California is the market destination for most of our cattle.

Free range in Arizona and consequent low cost of production belong to the past. Ranching expenses now include charges for the principal items of interest, land leases, labor, groceries, taxes, repairs, feed, etc. The sole source of income is from the cattle and sales are made usually in the late spring or in the fall of the year. Cattle ranching in Arizona is typical of the more extensive type. The ranches are large, the carrying capacity for the most part is low, water is expensive to provide, more bulls are required, and the percentage calf crop for the State as a whole

is variously estimated at from 30 to 50 percent of branded calves. In favored areas, under excellent management a much better calf crop may be secured. Percentage calf crops as high as 90 to 95 percent have been reported on the better ranges in favored seasons. The cattle-feeding areas in Arizona are in the irrigated valleys centering around Phoenix, Yuma, Safford, Florence, Casa Grande, and Tucson. The range country surrounding these valleys affords a continuous and convenient supply of feeder stock. The feeds most commonly used are hegari (grain sorghum) preparations, alfalfa hay and pasture, cottonseed products (chiefly meal) and some cereal grains, principally barley. Owing to the mild winter climate, extensive feeding equipment is unnecessary. Fences, corrals, feed troughs, hay racks, and watering facilities must be provided and silos are advisable. Shelters are not usually erected.

The history of the cattle-feeding enterprise in Arizona shows that it has been at times a speculative and hazardous business. It is highly specialized and requires considerable capital, close supervision, and much practical experience in the purchasing, feeding, and marketing of livestock. However, the favorable climate, the productiveness of the irrigated land, the proximity to ample feeder cattle, and a well established market for the finished product are natural advantages which assure permanence to the industry.

SHEEP

Sheep production in Arizona is not a statewide activity. The part of Arizona which is made use of by the sheepmen is located in the central and north central parts of the State. It extends from Phoenix and the Salt River Valley north to the Grand Canyon, and from a point on the western boundary near Kingman to a similar point on the eastern boundary near Springerville. The geographical center of the industry coincides approximately with the geographical center of the State. The sheepmen of Arizona hold most of their land in the form of National Forests, Public Domain, and land leased from the State. Approximately one-half million sheep are wintered on the lower mesa ranges contiguous to the irrigated sections. During the dry seasons the sheep are pastured in the valleys or supplemental feed is provided from the same sources. In the spring, these sheep are driven over trails, or wide strips of land set aside for this purpose, onto the National Forests where grazing permits are held by the owners.

Four general systems of sheep management are in practice in this State. These systems were devised in response to production requirements and they are named in keeping with the time of lambing: "Early

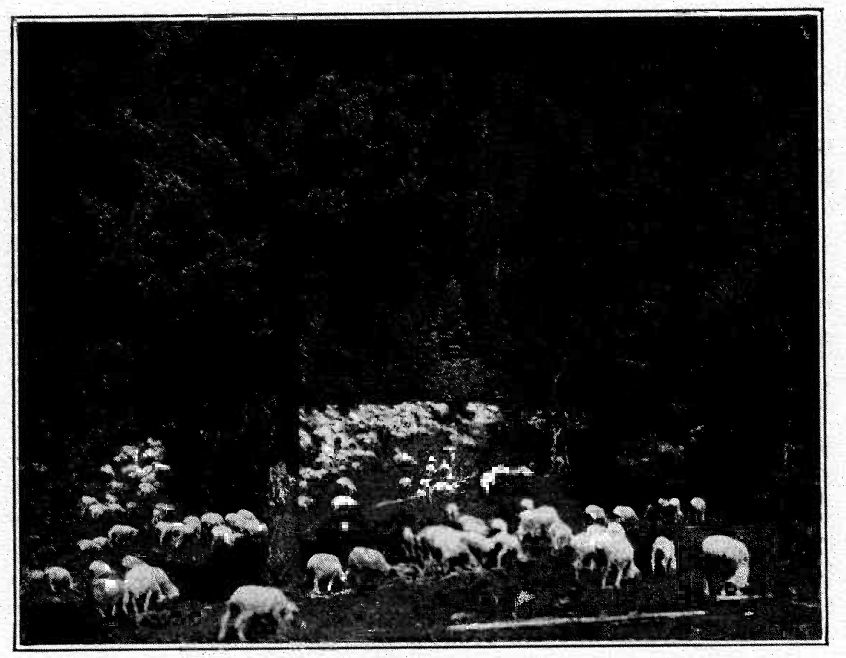

Fig. 12.—Sheep on summer range on a National Forest in northern Arizona.

lambing," "February lambing," "May lambing," and "combination lambing." Early lambs are marketed from the green pastures of the irrigated valleys in the early spring. The product of the February lambing system goes to the market in the late summer, mostly as fat lambs. The May lambs are marketed in the fall of the year, principally as feeders, but with a grass-fat "cut" the size of which depends upon the favorableness of the season.

Over 95 percent of the ewes kept for breeding purposes are Rambouillet, or ewes showing a preponderance of Rambouillet blood. Most of the lambs produced are "white faced" lambs though some of them, particularly those destined for the early market, are the product of the mating of "black-faced" rams with Rambouillet ewes.

The fattening of lambs, though practiced to some extent in the irrigated valleys, is a minor livestock enterprise in Arizona. The conditions under which they are fed, the equipment necessary and the feeds used are practically identical with those discussed under the heading, "Cattle." The finished lambs are usually marketed either in Kansas City or on the California markets.

SWINE

Except for occasional hogs kept for family slaughter, the hog producing area is confined to the irrigated valleys of the State. In past years, because of the high price of grain and the rigors of very hot summers, the production of market hogs has not usually proved especially profitable. A limited number of hogs have been kept for the consumption of garbage, dairy by-products and other waste materials of the farm. The future development of the swine industry in Arizona is dependent upon the amount of grain produced and upon the price which can be realized from feeding it to hogs, as compared to the returns from other competing livestock.

GOATS

The so-called oak-chaparral belt of Arizona seems to be especially suited to goat production. This strip of land extends diagonally across the State from near Kingman in the northwest to the Roosevelt Dam and continues on in a southeasterly direction. These are rough mountainous ranges showing a minimum of grasses and a maximum of shrubbery, chiefly oak. Practically all of the goats are of Angora breeding and the market products are kids and mohair.

HORSES, MULES, AND BURROS

The production of these classes of livestock in Arizona is usually a secondary enterprise. Many ranches breed mares for the production of "cow horses." Most of the draft horses and mules that find use in the farming areas are shipped into the State. Burros are a product of the range and a limited number of them are used as pack animals by cattle, sheep, and goat outfits.

DAIRYING

Dairying holds an important position in Arizona's agriculture. It supplies a market for home grown feeds, helps to maintain soil fertility, provides steady employment to thousands of people and furnishes several essential human foods.

While the number of dairy cows in Arizona has remained fairly constant during the last 5 years, there has been some increase during 1931 and 1932 due to less culling, less demand for cows from outside markets and the fact that dairying was more profitable than most other lines of agriculture during 1930 and a part of 1931. The number of cows and heifers over 2 years of age kept for milk production averaged between 35,000 and 36,000 during 1927 to 1930, inclusive, while the preliminary estimate for 1932 is about 42,000. Home production does not supply

the local demand which necessitates the shipping in each year of large quantities of dairy products, especially butter and cheese.

All of the principal dairy breeds of cattle are represented in Arizona. The Holstein Friesians predominate in numbers followed by the Jersey, the Guernsey, and the Ayrshire breeds in the order named. There are also a few herds of Brown Swiss and Dutch Belted cows. All of these breeds thrive and produce well under the feed and climatic conditions of the State. The choice of a breed for an Arizona farm should be based on other factors such as the market demand for surplus animals, quality of milk, and the preference of the owner. The registered herds of dairy cattle carry the blood of some of the most famous sires of the country. There are to be found in these herds some high milk and butter-fat producers as well as excellent types of individual animals.

Commercial dairying is confined largely to the irrigated sections of the State, principally the Salt River Valley, the Yuma Valley, the Gila River Valley in the vicinity of Safford, the Casa Grande Valley, the Sulphur Spring Valley, and the Santa Cruz Valley. In recent years there has been some dairy development in northern Arizona, mainly in Navajo and Apache counties, where the product is used largely for butter and cheese making. Dairying in other sections of the State is devoted chiefly to the production of market milk for local consumption.

Alfalfa is one of the leading crops of the State and provides the major portion of feed for the dairy herds. Silage crops such as corn, sweet sorghums, and grain sorghums produce large tonnages and provide a cheap and desirable feed for supplementing alfalfa hay. The trench silo has proved to be very satisfactory in Arizona and this type of silo can be constructed at very little cost. The concentrates which are produced within the State include corn, barley, oats, hegari, milo maize, wheat bran, and cottonseed meal. It should be noted that there is no shortage of protein feed in Arizona inasmuch as alfalfa is the leading forage crop and wheat bran and cottonseed meal are by-products of Arizona's mills.

The climate of southern Arizona is favorable to both winter and summer pasture. In summer, alfalfa, Sudan grass, and sweet clover are the favorite pastures. Sudan grass can be planted in April and May and be ready for pasture late in May or early in June. It does not stand much cold weather. Alfalfa can be pastured any month in the year but furnishes a large amount of feed from April to November. When cattle are grazing on alfalfa, some care must be taken to prevent bloating. In winter, barley, wheat, and oats pastures are the most popular. Of these, barley furnishes the most feed during the cold

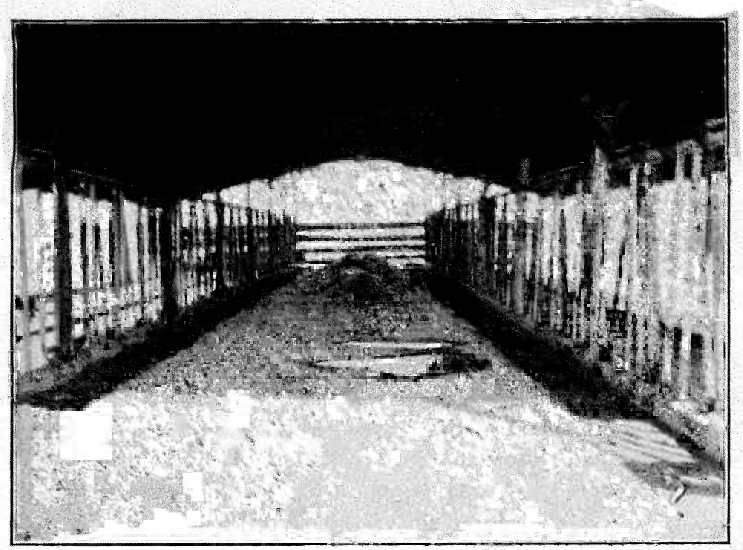

Fig. 13.—Typical southern Arizona dairy barn; stanchions and roof, but no side walls.

months but it has a tendency to taint the milk more than does wheat or oats. Practically all pasturing of dairy cattle is done on irrigated fields as the native grasses on unirrigated land do not provide sufficient feed to justify their use for dairy purposes.

The mild climate of southern Arizona makes expensive buildings unnecessary. The cows are not kept in barns. They remain in the open night and day, winter and summer, and are fed roughages in feed racks or mangers placed in the pastures. The milking stables ordinarily used consist of a roof, a concrete floor, mangers, manure gutter, and stanchions. Usually, there is no siding and no place for feed storage. In a few cases, however, the building used for feed storage has one or two sides devoted to milking facilities so that the roughage as well as grain can be fed to cows while confined in the stanchions. In any case, the cows are turned out as soon as the milking and feeding operations are finished. Separate milk rooms are required by State law for the handling of the milk. These are usually cheaply constructed with a concrete floor and are screened from flies. The overhead in buildings and equipment is thus much less than is required in areas of more severe climate. In northern Arizona, however, the winters are cold and dairy cows do better there if given protection from the winter winds and storms.

Creameries or cream stations are located in all the dairy sections of the State, so the dairyman is assured of the market price for his product.

Butter, ice cream, and evaporated milk are the principal manufactured dairy products although considerable cheese is made during the summer. The Federal Bureau of Agricultural Economics shows that 1,994,000 pounds of butter were produced by the creameries of Arizona in 1930. The present creameries are equipped to manufacture much more than this amount of butter and if the output were larger the manufacturing could be done more economically than is now the case.

The sanitary aspects of the dairy industry are regulated by a State Dairy Law administered by a State Dairy Commissioner located at Phoenix. Each city, in turn, has an ordinance and a city inspector to properly regulate milk sold within the respective urban districts. The State Veterinarian, also located at Phoenix, administers the law with respect to diseases of livestock. The State of Arizona is cooperating with the Federal Government in the eradication of tuberculosis among cattle. No cattle can be shipped into Arizona without certificates signed by accredited veterinarians which state that the animals have been tested and found to be free of tuberculosis and infectious abortion.

POULTRY

Less capital is required to become established in the poultry industry in Arizona than in almost any other phase of agriculture. Three acres of land will supply space enough for a home and at least 2,000 mature birds. Equipment, such as housing, is comparatively inexpensive. In many instances a small flock of hens on the farm, in addition to supplying eggs and poultry meat for the family, pays the grocery bill. With a flock of commercial size many people have been able to make a comfortable living.

Due to its mild climate, high percentage of sunshine, and low humidity, Arizona is an ideal place in which to raise poultry for heavy egg production. The dry spring weather lessens the usual troubles experienced in raising young stock. It is difficult to say which section of the State is best suited to poultry raising, since each has its peculiar advantages. The poultry industry is developing rapidly in the vicinity of Douglas, which is located near the Mexican Line in southern Arizona and has an altitude of 3,930 feet. Its mean annual temperature is 62° F., with temperatures as high as 104° F. in June and as low as 12° F. in January. The annual precipitation is 12 inches. Nogales is located 70 miles south of Tucson and has an altitude of 3,800 feet. On account of its location it has a good outlet for poultry products on the west coast of Mexico in addition to the local market. The mean annual temperature is 60.3° F. The highest summer temperature 105° F., and the lowest winter tem-

perature 15° F. in January. The annual rainfall is 13 inches. The upper Gila Valley in which Safford is located is one of the important irrigated sections of the State in which some small grains are raised which can be utilized by poultry. Although general farming is a common practice in this section, there are many commercial poultry farms. In normal times their output goes to the nearby mining towns. The Sulphur Spring Valley in and around Willcox in the southeastern part of the State also offers very good opportunities for poultry raising. The chief outlets for poultry products from this section are the large mining towns of Globe, Bisbee, Douglas, and Cananea, Mexico. Tucson is located in the center of one of the largest poultry centers in the State, and consumes most of the poultry products raised locally. The altitude of Tucson is 2,400 feet. The mean annual temperature is 66.4° F. The highest temperatures in summer usually occur in June and range from 104° to 110° F. The lowest temperatures range from 22° to 15° F., and occur in December and January. The yearly precipitation at Tucson averages 10.6 inches. The country about Casa Grande and Florence offers very good possibilities for poultry raising, inasmuch as the Coolidge Dam gives the section irrigation water which should assure rapid agricultural development. The climatic conditions are somewhat similar to Tucson, although the altitude is lower.

The Salt River Valley, representing one of the largest poultry-producing centers in Arizona, has both the farm flock and commercial plants contributing to its poultry industry. The outlet for poultry products is largely within the Valley itself, inasmuch as several towns

Fig. 14.—Arizona poultry scene.

and cities including Phoenix, Mesa, Tempe, Chandler, Glendale, Peoria, Scottsdale, Gilbert, and Buckeye are located there. Eggs are also shipped to the mining towns of Ray, Sonora, Superior, Hayden, Globe, Miami, and Ajo, when the mines are operating. The altitude of Phoenix, the largest city in the Salt River Valley, is 1,108 feet. The mean annual temperature is 69.9° F., with high temperature of 105° to 115° F. in June, and temperatures as low as 27° F. to 20° F. in January. The yearly precipitation is 7 inches.

In the northern parts of the State, around Prescott and Flagstaff, conditions are favorable for poultry, although this section has a much greater altitude and is colder than is the southern part of the State. Here more expensive houses are required. Prescott is located in the central part of the State at an altitude of 5,300 feet. Its mean annual temperature is 52.4° F. It has temperatures as high as 100° F. in June and occasional temperatures as low as 2° below zero in December and January. Flagstaff is in north-central Arizona at an altitude of 7,000 feet. Its summers are cool with temperatures as high as 90° F., and its winter temperatures occasionally drop as low as 15° below zero. At times the winter snows are deep. The annual rainfall at Flagstaff averages 23 inches.

The lower Colorado River Valley in southwestern Arizona also offers good opportunities for poultry raising. The chief city is Yuma. It has an altitude of 150 feet, a mean annual temperature of 71.6° F., a high summer temperature of 110° to 117° in June and low temperatures of 28° to 24° F., in January. The annual rainfall is 3.5 inches. There are a number of mining towns in widely separated parts of the State that are exceptionally good locations for poultrymen, and there is usually a scarcity of poultry products in these towns. These include such towns as Jerome, Globe, Miami, Clifton, Morenci, Hayden, Ray, Superior, and Ajo.

Marketing in Arizona is still a question of supplying local needs. Every town of any size in the State offers a market for both poultry and eggs, so that the question of marketing is a comparatively simple one. Until production increases to a point where the supply cannot be used within the State, there is little need for a marketing organization other than local poultry associations to assist in distributing the products to the local markets.

The general practice is for poultrymen to purchase the feeds used on their farms, as this has been found to be more economical than to attempt to grow the feed, except in those irrigated sections where the water costs make it possible to produce small grains profitably. Even under these conditions it is necessary to purchase concentrates and

supplementary feeds. With the prices of feed in 1932, it costs approximately $1.50 to feed a mature bird for a year. There is an ever increasing tendency to utilize locally-grown, small-grain crops for poultry in order to decrease feeding costs.

The mild, warm climate of southern Arizona has made it possible to house poultry virtually out of doors by placing the roosts on tables in the open. The cost of housing with a system of this kind need not exceed 20 cents per bird. This system has been found practical. Where the orthodox, complete house is used the cost per bird would be increased to at least $1.00 per bird. The more expensive type of house would be necessary in the colder sections of the State.

ANIMAL DISEASES

Arizona possesses certain natural advantages which help to minimize animal disease problems. The hot, dry climate with its abundance of sunshine acts as a distinct handicap to the development of most infectious, disease-producing organisms. On the other hand, certain nutritional diseases and certain ailments caused by the lower animal forms, for example screwworms, are more prevalent because of those same climatic conditions.

Range livestock production is naturally extensive. The livestock population is spread out over the ranges and this well distributed population retards the spread of infectious diseases. The irrigated valleys, in which the animal population is more concentrated, are more or less isolated which is an advantage in preventing the spread of disease epidemics. Range livestock losses in Arizona are caused by nutritional deficiencies, poisonous plants, predatory animals, and by animal diseases both infectious and non-infectious. Nutritional deficiencies may not always culminate in death but may be evidenced according to degree by an unthrifty condition, unsatisfactory gains, and by failure to breed or reproduce. The one greatest cause of feeding troubles is stocking the range to capacity in good years which causes an overgrazed condition in drought years, and also in the spring of the year when the cured native feeds are inadequate to supply the gestating cows with adequate nutrients. When conditions are extremely bad, cows are likely to abort their young or to die at parturition. Losses from poisonous plants are often incurred in times of feed shortage when the animals are driven to eat plants that otherwise would not be consumed. The loco weed, larkspur, water-hemlock, death-camas, lupine, whorled milkweed, rayless goldenrod and Johnson grass have been reported as causing death losses among livestock in Arizona. The losses from poisonous plants do not occur regularly through the growing season but are of a sporadic nature.

Predatory animals are the cause of heavy losses in range livestock. Wolves and mountain lions are the most persistent offenders. The Biological Survey of the United States Department of Agriculture is doing effective work in killing predatory animals in the State and in reducing the amount of loss caused by them.

Screwworms take a fairly heavy annual toll from Arizona livestock producers. Cuts, wounds, thorn pricks, and other skin abrasions during the fly season almost invariably result in a case of "worms." Riders and herders are seldom without their screwworm medicine during the summer season. *Hemorrhagic Septicemia* is an infectious disease that is sometimes encountered in cattle, sheep, and swine. The losses caused by this disease are often increased by diseases of a similar nature such as pneumonia, influenza, and other complications of the respiratory and intestinal tracts. Tuberculosis and infectious abortion are rare among range livestock. In addition to the losses discussed above many Arizona cattle die annually from the disease known as "blackleg." The losses from this disease, however, are decreasing from year to year. An effective vaccination program on the part of the cattleman will enable him to avoid most of this trouble.

Stomach worms cause some trouble with sheep, particularly in those flocks in the southern part of the State which are confined to small areas or pastures.

Outbreaks of hog cholera occur occasionally in the irrigated sections. The vaccination treatment for this disease is effective and is recommended to all hog producers. When large numbers of hogs are kept under crowded conditions the usual diseases and complications are encountered, though in commercial production when adequate equipment and pastures are provided, sanitary conditions are easily maintained.

Livestock producers in Arizona encounter a host of other diseases and minor ailments of cattle, sheep and swine in addition to those enumerated above but the losses resulting from them usually are not great. The Livestock Sanitary Board of Arizona and the State Veterinarian are giving effective service to the livestock industry and are doing much to prevent losses from contagious diseases.

As is true in most states, the two diseases most important to dairy cattle are infectious abortion and tuberculosis. The State Veterinarian is cooperating with the Federal Bureau of Animal Industry in the eradication of tuberculosis and this disease now seems to be well under control. There are many accredited herds in the State. Of more than 3,300 dairy cattle tested during May, 1932, only 2 percent were reactors. The University is cooperating with the veterinarians of Arizona in testing cows for abortion and every effort is being made to eradicate this

disease by means of segregation of reactors. Much progress already has been made. The dairy cattle of Arizona are also subject to various other ailments more or less common to dairy cattle generally. Some of the most common are garget or mammitis, milk fever, bloat, and pink eye. Dairy cattle are also bothered to some extent with blue lice. This is especially true of young stock that are thin in flesh.

In spite of the warm, dry climate with which most of the State is favored, certain of the poultry diseases are quite prevalent in Arizona. An estimate of the annual loss of mature birds from the larger flocks would be approximately 20 percent. Although this may seem high it is only about one-half of the loss suffered by certain of our neighboring states from the same causes. The reasons for these losses are many and varied. Some of them can be brought under control and eradicated, others are beyond control due to a lack of knowledge regarding them. The more important diseases which cause greatest concern are, infectious bronchitis, paralysis, intestinal parasites and cocidiosis. In addition to these, roup in its two forms, chicken pox, and bacillary white diarrhea, and various forms of egg troubles are occasionally encountered. Altogether, the question of poultry diseases is one of much importance to the industry, nevertheless considerable headway is being made in control and eradication.