

TYPE OF FARMING AND RANCHING AREAS IN NEW MEXICO

PART I

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CONTENTS

	Page
Objective	5
Sources of Information	5
Definition of Terms	6
Size of Farm and Gross Income per Farm by Type	8
Historical Background	9
Major Types of Land Tenure	13
Population	17
Factors Influencing the Agricultural Development of New Mexico	17
Physical Factors	18
Surface Relief and Drainage Basins	18
Climate Characteristics	19
Soils	25
Types of Natural Vegetation	27
Biological Factors	30
Animal Diseases	30
Plant Diseases	31
Insect Pests and Internal Parasites	31
Barnes and Predatory Animals	32
Weeds	32
Plant Adaptation	32
Economic Factors	33
Distance to Market	33
Transportation	33
Competition	34
Nepressed Machinery and Implements	34
Maps Agricultural and Adjustment Problems	34
Land-Use Adjustments	34
Overstocking the Grazing Lands	35
Soil Conservation	37
Stabilization of the Supply of Irrigation Water	37
Efficient Use of Irrigation Water	38
Drainage of Irrigation Lands	38
Size-of-Farm and Low-Income Problem	38
Geography of the Agriculture of New Mexico	39
Distribution of Crops	40
Distribution of Livestock	45
Distribution of Farms by Type	46
Type-of-Farming and -Ranching Areas	48

FOREWORD

The results of the study of types of farming and ranching in New Mexico conducted cooperatively by the New Mexico Agricultural Experiment Station and the Bureau of Agricultural Economics, U. S. Department of Agriculture, are to be published in two separate bulletins, Part I and Part II. Part I presents the reasons for making the study, the basis for classifying the farms into types, and the major types of land tenure, and sketches the agricultural development of the State.

It presents, further, a discussion of the physical, biological, and economic factors which have influenced and largely determined the kinds of farming and ranching to be found in different parts of the State. Lastly, it presents a series of figures which show approximately where the principal crops are grown, where the different kinds of livestock are produced, and where the more important types of farming are carried on.

In this study the State has been differentiated into 25 type-of-farming and ranching areas and 33 subareas. Part II presents a somewhat detailed description of each of the 25 type-of-farming areas and also of the 33 subareas. Both Parts I and II should be read in order to obtain a comprehensive understanding of the agriculture of the State.

TYPE OF FARMING AND RANCHING AREAS IN NEW MEXICO¹

PART I

OBJECTIVE

A type of farming and ranching study has been conducted in New Mexico in order to acquire a comprehensive understanding of the agriculture of the State as a whole; to point out why the agriculture is as it is; to determine what types of farming and ranching are to be found in different parts thereof; to differentiate the State into zones and sub-zones in each of which the agriculture differs from that prevailing in adjoining areas; to describe each of these areas and the agriculture thereof; to ascertain the nature and significance of the major problems which confront the farmers and ranchmen of the State; and finally to suggest along what lines major adjustments may be undertaken.

SOURCES OF INFORMATION

The principal sources of the data used in the preparation of this bulletin are as follows: The Bureau of Agricultural Economics, the Bureau of Chemistry and Soils, the Bureau of Forestry, the Weather Bureau, the Soil Conservation Service, and the Agricultural Adjustment Administration of the United States Department of Agriculture; the Bureau of Census, United States Department of Commerce; the Bureau of Reclamation and the Geological Survey, United States Department of the Interior; and the Experiment Station and the Agricultural Extension Service of the New Mexico College of Agriculture and Mechanic Arts. The economic field studies which have been conducted by the Department of Agricultural Economics of the New Mexico College of Agriculture and Mechanic Arts have been especially helpful in making the study a success. During the study the authors visited each of the type-of-farming areas into which the State has been divided, in order to check and correct the various figures and maps which show the geographical distribution of the population, the principal crops grown, the different kinds of livestock produced, and the types of farms and ranches to be found within the State.

DEFINITION OF TERMS

Since the terms "farm," "type of farming," "type-of-farming area," and "carrying capacity" are used repeatedly in the discussions which

¹The authors gratefully acknowledge the assistance of many State Experiment Station, Extension Service, and Federal workers who informally assisted in assembling the data incorporated in this report and in reviewing the manuscript. They are especially indebted to K. W. Parker, formerly Assistant Animal Husbandman, New Mexico Agricultural Experiment Station, for preparing figure 4 and furnishing the discussion of "Types of Natural Vegetation"; and also to E. C. Woodard, formerly Associate Agricultural Economist, Bureau of Agricultural Economics, for preparing figure 2.

follow, it is essential at the outset that the reader have a clear conception of their meaning. In this bulletin these terms are used in much the same sense and with practically the same significance as they are in the publications of the 1929 United States Census of Agriculture.

FARM

"A farm", for census purposes, is all the land which is directly farmed by one person, either by his own labor or with the assistance of the members of his household or hired labor. The land operated by a partnership is likewise considered a farm. A farm may consist of a single tract of land or of a number of separate tracts, and these several tracts may be held under different names, as when one tract is owned by a farmer and another tract is owned by his wife. When a landowner has one or more tenants, renters, or managers, the land operated by each is considered a farm. . . . The enumerators (Censuses) were instructed not to report as a farm any tract of land of less than 3 acres, unless its agricultural production in 1929 was valued at \$250 or more."

TYPE OF FARMING

The basis used by the Bureau of the Census for classifying farms and ranches into types follows: "Source of income (gross), that is, the value of the products from a particular source in relation to the value of products from all sources is the primary basis used in classifying farms into types. 'Source' relates to the product or products from which the income is derived, resulting from the sale of a single product in certain cases, and from a group of products in other cases. Products used on the farm itself are not included except those for family consumption which are combined into one total." On this basis the farms and ranches of the State in 1929 were classified by the Bureau of the Census into 13 major types, one of which was again divided into 2 minor or subtypes. Both the major and minor types are listed below. The product or products from which the gross income was derived are also listed for each of the first 9 types; i. e., with grain to poultry, inclusive. In the case of each of these 9 types, the gross value of the product or products which constituted the source of income for each type had to equal 40 percent or more of the total gross income from all sources, since no other source contributed as much as 40 percent. Definitions are given for each of the other 4 major types and for the minor types.

Cash grain—Wheat, grain sorghums, corn, oats, barley.

Cotton—Cotton.

Crop specially—Hay, dry beans, potatoes, sweet potatoes, tomatoes, alfalfa seed.

Fruit—All tree fruits, all small fruits, and grapes.

Edwinton C. S. Census of Agriculture, New Mexico, 1910, Type of Farm, Statistics by Counties, Third Series.

Ibid.

Track—All vegetables harvested for sale.

Dairy—All dairy products, dairy cows, and dairy calves.

Animal specialties—Beef cattle, sheep, goats, hogs, veal, and mutton. This type has less than 10 acres of pasture land to each acre in crops.

Stock ranch—Beef cattle, sheep, goats, hogs, veal, and mutton. This type has 10 acres or more of grazing land to each acre in crops.

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

General—Farms which had incomes both 1 or more acres, none of which contributed 40 percent of the total gross income, or farms which had 40 percent or more of the gross income from each of 2 sources.

Self-sufficing—Farms on which the operator's family consumed 50 percent or more of the total value of all products produced.

Unclassified—Farms not reported in 1928, or farms for which the reports were too incomplete to permit of classification.

Abnormal—Farms which are unusual and which differ materially from ordinary farms. This type has been divided into 8 groups or subtypes, part-time, border and colony, forest-products, horticulture, country estate, horse feed, and livestock dealer. Part-time farms are of considerable importance in New Mexico and are defined below. For definitions of the other seven subtypes, which are of very minor importance in the State, the reader is referred to the U. S. Census of Agriculture, 1920.

Part-time—Farms which produced products in 1928 valued at not more than \$750 and whose operators reported either other occupations than farming or the spending of at least 150 days at work not connected with their farms.

With one exception, in the discussions which follow, the classification of farms into types presented above has been followed. The two types, "animal specialties" and "stock ranch," have been combined to form one type, "stock farm and ranch," figure 22. Under New Mexico conditions it is deemed best to combine the two and to use them as one type.

From the definition of the respective types of farms presented above, it is evident that wide variations may be expected in the organization and operation of the individual farms which make up each of the several types. In the case of the cash-grain farms, for example, the necessary 40 percent of the gross income may have been derived from the production of any one or from several combinations of the 5 grain crops (wheat, grain sorghum, corn, oats, and barley) grown in New Mexico. Thus, some of the cash-grain farms may have derived the bulk of their gross income from wheat, others from corn or from grain sorghum, and still others from any two or more of the same crops. Likewise the stock ranches vary widely from ranch to ranch. On some ranches only one kind of livestock is produced; i. e., either cattle, sheep, goats, or hogs. On others, there is a combination of cattle and sheep, or cattle, sheep, and goats. Thus, there are purely cattle ranches, sheep ranches, goat ranches, or ranches which carry two or more of the livestock enterprises. Similar variations may be pointed out with respect to organization and operation of the individual farms making up each of the other types and subtypes.

11; cash-grain, 10; cotton, 10; truck, 2; dairy, 2; and fruit and poultry, 1 percent each.

The average size of farm by types varied from 32 acres for the truck farms to 3,611 acres for the stock farms and ranches combined. Considered separately, the stock farms (animal-specialty) averaged 152 acres in size and the stock ranches 4,095 acres. In considering the average size of the respective types, it must be kept in mind (1) that the grazing lands of the national forests and also of the unincorporated public domain used by stock producers are not included in the size averages given in table 1, and (2) that the size of farm varies widely within each of the different types. A very high percentage of the stock ranches is in grazing land. Vast areas of grazing land in the National Forests, in the public domain and also in State-owned lands are used in connection with the operation of the stock farms and ranches.

The average gross income for each of the 15 major types of farm is shown in the last column of table 1, the variation being from \$204 for the self-sufficing farms to \$4,594 for the stock ranches. It will be noted that in 1929 there were 2,305 general farms in New Mexico averaging 399 acres in size, with gross incomes averaging \$1,190, of which \$400 was derived from crops, \$227 from livestock, \$252 from livestock products, and \$900 from farm products. The remaining \$213 of the gross income represents the value of the farm products used by the operator's family. The average gross income of each of the other types presented in table 1 may be suspected in the same way.

HISTORICAL BACKGROUND

The territory included within the present borders of New Mexico was acquired by the United States by the annexation of Texas in 1845, by the Treaty of Guadalupe Hidalgo, signed in 1848, and by the Gadsden Purchase of 1853. These two treaties provided that the United States should pay Mexico indemnities of \$15,000,000 and \$10,000,000, respectively, and that Mexico should cede to the United States all of her territory lying north of the present Mexico-United States boundary line and west of the Rio Grande. The United States also paid the State of Texas \$10,000,000 to relinquish her claim to all that part of New Mexico lying east of the Rio Grande. While a territorial government was set up in 1850, it was not until 1912 that New Mexico was admitted to the Union as a state.

The information presented under the above caption has been gathered largely from:

1. Conant, Katharine, "Elements Beginning of the Far West," Vol. I and II.
2. Blum, L. B., and Donnelly, T. C., "New Mexico History and Census."
3. Switthell, R. E., "Leading Facts of New Mexico History."
4. Battersoff, H. H., "Blatancy of Arizona and New Mexico."
5. Squires, A. H., National Geographic Magazine, Vol. XLVIII, No. 6.

Historically, New Mexico can boast of having the oldest agriculture in the United States of which there are authentic records. The Spaniards began to explore the State in 1540 and so colonize it as early as 1598. They found the Indians growing corn, beans, calabashes, and cotton; diverting water from the streams to their cropland in artificial communal ditches; weaving baskets and cotton cloth; making fur and leather blankets; and molding pottery of various forms, symbolically decorated. The natives knew but little about metals. Their tools, utensils, and weapons were made of stone, wood, bone, clay, and leather. They were, however, skilled in tanning. It has been estimated that about 25,000 acres were irrigated by the Indians who once lived in the middle valley of the Rio Grande. Thus, it appears, the natives had been practicing a very simple type of agriculture for many generations before the advent of the Spaniards.

The Spaniards introduced the use of metal tools, utensils, and weapons, and the wooden plow; they brought with them practically all of the domestic animals (horses, cattle, sheep, goats, hogs, and chickens). They also introduced the small grains, vegetables, tree fruits, and grapes. Wool soon became an important medium in the weaving of cloth.

From the date of the first colonization venture (1598) until Mexico gained her independence (1822), New Mexico had virtually no outlet for her products and no source for obtaining supplies except by way of Chihuahua City and Vera Cruz. During that period of more than two hundred years, development was very slow and the exports consisted mostly of sheep, wool, dressed skins, buffalo robes, furs, salt, and finely fashioned copper vessels. As a rule, the balance of trade was overwhelmingly against New Mexico. The policy pursued was intended to keep the colonies short of funds and to prevent them from forming outside commercial connections. However, as soon as Mexico obtained her independence, the commercial policies were changed; traffic over the Santa Fe Trail materially increased and a thriving commerce between the Missouri River points and Santa Fe soon developed. This continued from about 1825 to 1845.

The annexation of Texas in 1845, the extension of the authority of the United States over the territory acquired as a result of the war with Mexico, and the discovery of gold in California in 1848 resulted in a great westward migration of people to the Pacific Coast. This westward movement was prolonged by the discovery of gold in Colorado some 10 years later. The Territory of New Mexico absorbed many of these immigrants and it was during this period that the value of the so-called "American Dream" for gaining purposes was discovered. It was during this period, also, that the range-cattle and sheep industries got under way. Although seriously hampered by Indian depredations, the Civil War, and the lack of market outlets, cattle numbers increased to such an extent that ranchmen, in 1865 and 1866, began trailing their herds to the north and northwest, in order to make connection with the new railroads building westward through Kansas. This continued until the

early 90's, when railroad transportation facilities became available in the eastern part of the Territory.

From 1870 to 1885 may be designated as a period of railroad expansion in New Mexico. During that time about 1,250 miles of track were laid; two transcontinental lines across the Territory were completed; the Santa Fe extended its line down the Rio Grande and connected with the Southern Pacific at El Paso and at Deming and the Denver & Rio Grande narrow gauge was extended south from Antonito, Colorado, to Española, New Mexico. Most of the railroads of the eastern part of the State were constructed after 1885, and the building operations covered a period of approximately 20 years.

The development of New Mexico was given a great impetus by the construction of the railroads. Thousands of men were required, first, to build the roads and then to operate them; much quicker and cheaper transportation was provided; the trailing of cattle long distances to find market outlets was discontinued about 1895; and finally the building of the railroads made it possible to expand greatly both irrigated and nonirrigated, or dry-farming, agriculture. The land now irrigated increased from approximately 291,000 acres in 1880 to over 500,000 acres in 1935. During that period, the Carlisle Reclamation project and much of the Roswell-Armasa district were developed. The Elephant Butte Dam was completed in 1915 and during the years which immediately followed the agriculture of the Mesilla and Blasco Valleys was greatly extended and stabilized. The development of the Middle Rio Grande Conservancy District is the most important extension of irrigation farming that has taken place within the State during recent years. The construction work on that project started in 1921. Nonirrigation farming began about 1900 in the west central part of the State at elevations above 5,000 feet and in the east central and the northeastern portions just prior to and following the passage of the 120-acre homestead act of 1900.

Table 2 shows the agricultural development of New Mexico during the 55-year period, 1880-1935. Of the total land area of the State (70,400,000 acres in round figures), 631,000 acres were in farms and ranches in 1880. This increased each census year, reaching 34,397,000 acres in 1935. The relatively slow development that took place during that period may be attributed, in large part, to the high proportion of the State that is either wilderness or rough or mountainous, and also to the extensive land areas that have been set apart as national forests, parks, and monuments, and as Indian and military reservations.

The total number of farms and ranches increased gradually during the 55 years, i. e., from 5,051 in 1880 to 41,369 in 1935. The average size of farm during that period varied considerably, the range being from 125 acres in 1880 to 912 acres in 1930. The development of irrigated tracts and projects from time to time has tended to decrease the average size of farm, whereas the passing of much of the unutilizable land into private ownership has made it possible for stock ranches, stock farms, and nonirrigated or dry farms to increase in size through

the process of consolidation. The proportion of farms reporting irrigation was much higher in 1920 than during any subsequent census year. This is due largely to the fact that nonirrigation farming developed, in very large part, after 1900.

TABLE 1.—CLASSIFICATION OF FARMS, LAND OPERATED, NUMBER AND SIZE OF FARMS, AVERAGE HARVESTS OF SPECIFIED CROPS, AND LIVESTOCK FOR FARMS RANGES, AND RANGES BY CENSUS YEAR, NEW MEXICO, 1890-1920.

Item	1890	1900	1910	1920	1929	1934	1939	1943
	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres
Land area irrigated	289,876	78,462	78,462	78,862	79,862	78,862	79,862	79,862
Land not irrigated	27,777	17,214	17,214	17,214	17,214	17,214	17,214	17,214
Land in farms	317,653	95,676	95,676	96,076	97,076	96,076	97,076	97,076
Improved land in farms								
Cultivated	122	80	80	80	80	122	1,044	1,044
Other improved	122	14	14	14	14	78	1,504	4,271
Unimproved land in farms	195,431	85,606	85,606	85,606	85,606	85,606	85,606	85,606
Land in ranges	11,111	11,111	11,111	11,111	11,111	11,111	11,111	11,111
Land irrigated	4	47	47	47	47	47	47	47
Land not irrigated	7	10,644	10,644	10,644	10,644	10,644	10,644	10,644
Range land irrigated	1	1	1	1	1	1	1	1
Range land not irrigated	6	10,643	10,643	10,643	10,643	10,643	10,643	10,643
Acres irrigated in farms	289,876	78,462	78,462	78,862	79,862	78,862	79,862	79,862
Acres irrigated in ranges	4	47	47	47	47	47	47	47
Crops harvested								
Wheat	48	31	31	31	31	31	31	31
Barley	48	31	31	31	31	31	31	31
Oats	48	31	31	31	31	31	31	31
Alfalfa	48	31	31	31	31	31	31	31
Other crops	48	31	31	31	31	31	31	31
Livestock								
Cattle	10	10	10	10	10	10	10	10
Sheep	10	10	10	10	10	10	10	10
Horses and mules	10	10	10	10	10	10	10	10
Swine	10	10	10	10	10	10	10	10
Other	10	10	10	10	10	10	10	10

The data presented are not strictly comparable, because of variations in the scope of which the respective census years range, and also because of variations in the methods used in gathering and tabulating the census data.

Not available.

Includes only irrigated land from which crops were harvested in 1920.

Includes only farms which reported the harvesting of crops from irrigated land in 1920.

Includes only farms in range.

Includes all crops harvested.

Large included.

Computed from U. S. Census of Agriculture reports.

The harvested crop averages presented in table 2, it should be remembered, are for the previous year. That is, the 734,000 acres of crops harvested is given in the last column of the table under 1935 represent the crops harvested during 1934. With that fact in mind a picture of crop production during most of the 55 years may be obtained by an inspection of the table. During the more recent census years corn, wheat, hay (mostly alfalfa), dry beans, and cotton have been the more

TABLE 3.—COWS, ESTIMATED HAMBURG¹ IN MILK OF SUPPLYING STATES, 1909-1910

Crops	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows	1,000 cows
All other cows	27	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61
Live	22	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55
Spring wheat	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Winter wheat	17	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Barley	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Oats	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Blue and orange	42	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75
Adults	36	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70
Male cows	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Female cows	34	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68
Non-lactating	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
All other cows	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Young	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Adults	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Female	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Other	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cows, estimated	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Live	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Spring wheat	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Winter wheat	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Barley	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Oats	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Blue and orange	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cows, estimated	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Live	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Spring wheat	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Winter wheat	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Barley	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Oats	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Blue and orange	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

¹Estimated by State College, Purdue Univ. Station, 1914-1930.
 Figures include only the cows
 counted from 1914-1930.

TABLE 4.—LIVESTOCK, ESTIMATED NUMBER ON FARMS, 1910-1914, AND SAVINGS (AMOUNTS), NEW MEXICO, 1914

Kind	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
Horses and mules	100	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270
Mules and ponies	30	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115
All cattle and heifers	100	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270
Cows and heifers (2 years old and over)	40	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125
Wethers (2 years old and over)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Swine (2 years and over)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Other livestock	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Total	150	150	165	175	185	195	205	215	225	235	245	255	265	275	285	295	305	315	325
Estimated savings (amounts)	100	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270

Estimated
savings (amounts) based on 1914 prices.
Source: U. S. Bureau of Agricultural Economics.

important crops grown. Owing to the severe drought of 1933, the harvested average of practically all crops decreased materially that year.

Table 2 also presents livestock numbers on the farms, ranches, and ranges of New Mexico by common years, 1870 to 1935. The production of range sheep and wooled was much earlier than that of cattle, reaching the highest peak around 1880, with nearly 5,000,000 head of sheep and lambs within the State. It appears that since 1920 production has never exceeded half that number. All cattle reached their highest peak (according to table 2) about 1920, with around 1,300,000 head on the farms, ranches, and ranges of the State. However, livestock estimates as presented in table 4 indicate that the highest peak occurred in 1934, when the number was approximately 1,560,000 head. Because of the changes in the dates at which the census was taken, the livestock numbers in table 2 should be compared cautiously.

Table 3 presents the estimated (Bureau of Agricultural Economics) harvested average of the more important crops grown each year in New Mexico during the period 1924-1932, inclusive. Seasons of drought, scant supplies of irrigation water, and variation in prices are the chief factors causing the shifts which have occurred in the harvested averages. Table 4 gives the estimated numbers of the different kinds of livestock on farms and ranches January 1, 1925-1939.

MAJOR TYPES OF LAND TENURE

Table 5 presents the total land area of New Mexico and also that of each of the 31 counties as divided into six major types of land tenure. Privately owned land made up approximately 45 percent of the total area; public land, 20 percent; State land, 36; national forests, 11; Indian reservations and trust allotments, 2; and national parks, national monuments, and military reservations together, less than one percent.

The data presented in table 5 should be considered only as fairly close approximations, because changes are taking place from time to time in the acreage making up some of the respective tenures and also because the source materials used in compiling the table were not always of the same date.

POPULATION

The United States Census credits New Mexico with having a population of 91,274 in 1870, that being the first year for which there is a complete census for the present area of the State. The population has increased slowly but steadily since 1870 and reached 425,317 in 1930, 68 of the total population that year, 23,941 were Indians.

The total land area expressed in square miles, the total population, and the number of persons per square mile as of 1930 for the State as a whole and for each of the 31 counties are presented in table 6. The average number of persons per square mile that year varied from 0.5 in Catron County to 37.3 in Bernalillo County. The second most densely populated county was Curry, with 11.2 persons per square mile. Santa

TABLE 2.—CASH CROPS OF LARGE FARMERS BY COUNTY, NEW MEXICO.

County	Total land owned?	Private land owned?	Public lands?	State lands?	Estimated acreage	Total acreage owned and leased, 1933?	Estimated yield per acre, 1933, and average (1933-34)?
Albuquerque	15,000	15,000	0	0	15,000	15,000	0
Catron	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Chaves	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Colfax	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Curry	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
De Baca	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Doña Ana	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Grant	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Hidalgo	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Huerfano	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Lincoln	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Los Alamos	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
McKenzie	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Mora	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Otero	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Quay	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Sandoval	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Santa Fe	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Santa Rita	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Teller	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Union	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Valencia	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Wheeler	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Yuma	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0
Total	1,000,000	1,000,000	0	0	1,000,000	1,000,000	0

U. S. Census of Agriculture, 1930.

Substantially the land held in private ownership.

National Land Office, Department of the Interior, 1933.

United States Census, Department of the Interior, New Mexico.

Office of Forestry, Department of Agriculture, 1933.

Office of Indian Affairs, Department of the Interior, 1933.

National Park Service, Department of the Interior and War Department, 1933.

In County then followed with 9.9 persons. The populations of the larger cities of the State in 1930 were as follows: Albuquerque, 26,570; Santa Fe, 11,176; Roswell, 11,172; and Clovis, 8,527. The United States Census of Agriculture credited no other city in the State with having as many as 7,000 in 1930. However, the cities mentioned above and also several others within the State have grown materially during recent years. Thus, Albuquerque in 1933 was credited with a population of 40,000; Santa Fe, 15,000; Hobbs, 12,500; Clovis and Roswell, 12,500 each; Las Vegas, 11,000; Carlsbad, 8,500, and Las Cruces 8,197. It is, therefore, evident that New Mexico has no very large cities within her borders, Albuquerque being the only one of sufficient size to in-

Road Map of New Mexico, 1934. Prepared by the New Mexico State Highway Department.

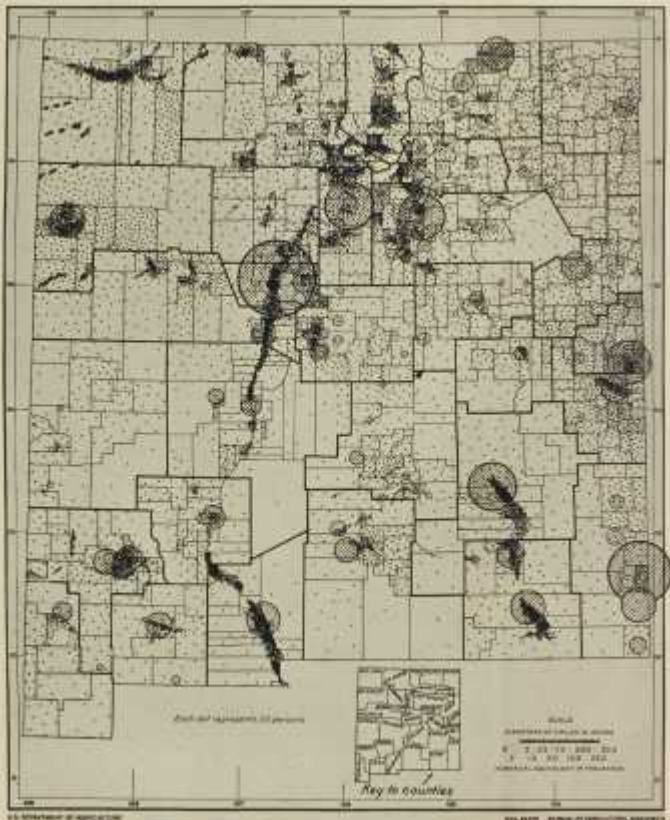


Fig. 1.—Population map, New Mexico.

TABLE 6.—LAND AREA AND TOTAL POPULATION BY COUNTY, NEW MEXICO, 1930

County	Land area in square miles	Population		County	Land area (in 1930) miles	Population	
		Total	Per square mile			Total	Per square mile
Brewster	11,547	471,397	41	McKinley	1,736	26,647	15
Bernalillo	1,752	45,433	25.4	Mora	1,974	31,117	15.4
Catron	7,790	7,195	9.2	Otero	4,488	8,777	1.9
Chaves	4,992	38,589	7.7	Doña Ana	2,967	36,393	12.3
Cibola	1,738	38,117	21.9	Hidalgo	1,271	21,351	16.8
Colfax	3,984	25,409	6.4	Huerfano	2,497	21,188	8.5
Curry	1,899	2,893	1.5	Lincoln	1,274	21,188	16.7
DeWalt	1,575	25,311	16.1	Los Alamos	1,476	14,757	10.0
Elbert	4,235	75,932	17.9	Los Lunas	4,294	22,636	5.3
Eschscholtz	1,889	16,691	8.8	Los Rios	1,361	14,567	10.7
Graham	2,021	7,627	3.8	Martinez	2,178	5,189	2.4
Haskell	7,113	4,437	0.6	Mason	3,138	8,691	2.8
Hidalgo	1,447	5,267	3.6	McCook	2,151	14,568	6.8
Lea	1,155	6,138	5.3	McMurry	2,799	9,399	3.4
Lincoln	1,777	7,138	4.0	Mohave	1,217	11,695	9.6
Logan	1,365	8,797	6.4	Navajo	1,158	18,155	15.7

Compiled from reports of United States Bureau of the Census.

flavors materially to modify the local types of farming which have developed.

The workers of New Mexico, 10 years old and over, gainfully employed in 1930 were distributed among the major industries approximately as follows: Agriculture absorbed 41 percent; manufacturing and the mechanical industries, 11; transportation and communication, 11; trades, 16; domestic and personal service, 6; professional, 7; extracting minerals, 6; industries not specified, 4; public service (not elsewhere classified), 1; and forestry and fishing, 1 percent.

The approximate distribution of the population of New Mexico is shown in Figure 1. Much of the State is very sparsely settled and the population is unevenly distributed. By comparing figure 1 with figure 21, which shows the principal irrigated areas, it will be seen that the greatest concentration of the rural population is about the cities, along the streams where water is available for irrigation, and in the nonirrigated or dry-farming sections in the eastern and central parts of the State. There is a strong tendency for the Indians and rural Spanish-Americans to dwell in small villages. Especially is this true in the north central part of the State.

FACTORS INFLUENCING THE AGRICULTURAL DEVELOPMENT OF NEW MEXICO

More than three centuries have passed since the white man first began to plant and harvest crops within the present boundaries of New Mexico. During all that time dynamic forces have been exerting material influences in the development of agriculture and in shaping and molding the various types of farming and ranching now to be found within the State. These forces naturally fall into three groups: The first group is physical in character, and includes such factors as surface relief, altitude, latitude,

climate, and soil; the second is biological in nature and is made up of such elements as crop adaptation, animal and plant diseases, insect pests, weeds, rodents, and predatory animals; the third includes such economic factors as distance from producing localities to shipping points and from shipping points to consuming centers, transportation facilities, demand for the products that can be produced, cost of production, and the prices which farmers and ranchers pay and receive. Brief discussions of the more important of these factors are given below, that the reader may better understand why the agriculture of New Mexico is as it is and why the State has been divided into type-of-farming and -ranching areas.

PHYSICAL FACTORS

SURFACE RELIEF AND DRAINAGE BASINS

New Mexico embraces a land area of approximately 122,700 square miles. Its greatest width from east to west is 352 miles and its greatest length from north to south is approximately 385 miles. The State presents a wide variation in surface relief, such as stream valleys, flat-bottomed dendritic basins, comparatively level plains, undulating to rolling plateaus, mesas, detached high ridges, and mountain ranges and mountainous areas, together with their associated foothills and intermountain valleys.

The Continental Divide, shown in figure 2 by the heavy continuous white line, ascends across the western part of the State. The other major watersheds are shown by broken heavy white lines. Thus, the State is divided into 14 separate drainage areas or basins. The surface runoff of basins 1, 2, and 3 drains into the Gulf of Mexico; that of basins 4, 5, 6, and 14 finally reaches the Gulf of Lower California, while basins 7 to 13, inclusive, have no surface drainage outlets, the rainfall of these seven basins being very scant. Basins 9 and 10 extend south across the State line into Texas. In like manner the southern portions of basins 11, 12, and 13 lie across the international boundary line to Mexico.

Elevations above sea level within New Mexico vary from about 2,050 feet, where the Pecos River flows across the State line into Texas, to 13,300 feet at the summit of Towhee Peak in the north central part of the State. Thus the State presents a range in altitude of a little more than 10,000 feet. Elevation and surface relief are closely associated with climate and have a marked influence on the length of the growing season, temperature, annual precipitation, and whether the precipitation falls as rain, snow, hail, or sleet. New Mexico has a range in latitude from north to south of 5° 47'. The influence of that distance on temperature is approximately equal to that of 1,000 feet in elevation.

CLIMATIC CHARACTERISTICS

Climatically, New Mexico is characterized by an abundance of intense sunshine, very little cloudy weather, wide variations in the length of the growing season in different parts of the State, considerable spread between day and night temperatures at any given point, low relative



humidity, scant annual precipitation, and very rapid evaporation of moisture from the surface of the ground. The prevailing winds are generally from the southwest and west. Owing to the influence of topographical features, the prevailing winds in certain localities are from the south and southeast.

Temperatures.—The weather observation stations of New Mexico are located at elevations ranging all the way from 5,120 to 10,000 feet above sea level. Nineteen stations are 4,000 feet or more above sea level. The highest temperatures, as a rule, occur in the relatively low lands bordering the Pecos River and the Rio Grande and in some of the flat-bottomed drainage basins of the southern part of the State. Low temperatures, on the other hand, occur in the high mountainous areas of the northern and western parts of the State. In general, the temperature increases from north to south as the altitude decreases. The average annual temperature at Santa Fe during a 76-year period, for example, was 48.9° as compared with 63.0° at El Paso, on the New Mexico-Texas state line, during a 43-year period. Along the southern border of the State and in much of the plains region, maximum temperatures of 100-110° occur quite regularly each year. The maximum temperatures at Roswell during a 27-year period ranged from 96-110 degrees. As a rule, however, the daily range is sufficiently great to cause the nights to be fairly cool and pleasant, even in midsummer. Furthermore, the dryness of the atmosphere tends to render both the heat of summer and the cold of winter less disagreeable to the human body. No part of New Mexico is exempt from temperatures of zero or below and in the mountain areas and on the high plains temperatures of 29° to 30° below zero may be experienced during the winter.

Length of Growing Season.—The length of the growing season, as measured by the frost-free period, is closely associated with minimum temperature and also with elevation. In the high mountain valleys of the northern part of New Mexico where the elevations are above 4,000 feet, the average length of the frost-free period ranges from about 75 to 105 days. In any given valley, it must be understood, there is likely to be a marked variation from year to year. For example, the frost-free period at the Bateman Ranch, in Rio Arriba County, where the elevation is 2,000 feet, varied during a 13-year period from 47 to 130 days. Under these conditions only the hardy vegetables, grasses, and grains may be grown successfully.

In the southern part of the State, on the other hand, the growing season is much longer. At the New Mexico College of Agriculture and Mechanic Arts, the frost-free period averaged 202 days during a 30-year period, the range being from 155 days in 1894 to 235 days in 1910. At Carlisbad, in Eddy County, the growing season is a little longer, the average being 217 days. Under the climatic conditions of the southern part of the State, cotton and a wide variety of other crops may be grown where water is available for irrigation.

Over much of the plains portion of eastern and northeastern New Mexico there is generally freedom from damaging frosts for a period of some 100 to 125 days. During exceptional years, however, the frost-free period in some localities may not exceed 145 days or it may be as much as 220 days. In the plateau region to the west, killing frosts may occur during the first half of May and again in the fall during the first half of October and sometimes late in September.

Precipitation.—Snow falls in all parts of New Mexico, the amount being closely correlated with both latitude and altitude. Of these two factors, altitude is by far the more important. Over a large portion of the lowlands of southern New Mexico, the snowfall seldom exceeds 10 inches and during some years there is some at all. Furthermore, what does fall usually melts in a very short time. In the foothill regions of that part of the State, the maximum may reach 15 to 20 inches and in the high mountainous areas as much as 70 inches. In the floor of the Rio Grande and the San Juan valleys in southern New Mexico, the annual snowfall averages less than 10 inches. The amount increases to about 30 inches over the plateaus and mountain slopes and it may exceed 50 inches where the altitude is as much as 5,000 to 9,000 feet. The greatest snowfall within the State occurs on the crests of the Sangre de Cristo and San Juan ranges, where the maximum exceeds 100 inches. It may even exceed 300 inches on the crest of the Sangre de Cristo Range.

The mean annual precipitation varies widely within the borders of New Mexico. Owing to abrupt changes in altitude in some localities, the changes may be very great within short distances. Figure 3 shows the State divided into rainfall zones by isohyetal lines roughly drawn to indicate a variation of 5 inches in the mean annual precipitation within each rainfall zone. Because of the long distance between many of the weather stations, it has been necessary in preparing this figure to locate more or less arbitrarily these lines of equal rainfall in some localities. Variation in altitude was given due consideration in making the map. The respective rainfall zones, therefore, are to be considered only as very close approximations.

Four areas which receive a mean annual precipitation of 10 inches or less and 10 relatively small areas which receive 50 inches or more are also shown in figure 3. Very generally, the zones having the highest precipitation coincide with the areas having the highest elevation, i. e., with the high mountain ranges and mountainous areas. In like manner the zones having a mean annual precipitation of 10 inches or less are located at relatively low elevations in the floors of river valleys or the basins having no surface drainage outlets.

Table 7 shows precipitation data for 35 Weather Bureau stations located in various parts of the State. The length of the record, the mean annual precipitation, the mean seasonal precipitation, and the percentage that the seasonal is of the annual are given for each of the 35 stations. The table also gives the standard deviation for both the mean annual and the mean seasonal precipitation.



FIG. 2.—Mean annual precipitation (inches), New Mexico.

TABLE 1.—PRECIPITATION, MEAN ANNUAL, AND MEAN SEASONAL AT SELECTED WEATHER STATIONS, 1932

Name and weather station	Range record		Wet season		Dry season		Mean annual precipitation		Precipitation in excess of normal
	Year	Inches	Months	Precipitation		Months	Inches		
				Wet	Dry				
Highlands New Mexico									
Alamo	1932	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1933	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1934	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1935	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1936	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1937	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1938	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1939	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1940	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1941	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1942	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1943	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1944	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1945	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1946	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1947	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1948	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1949	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1950	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1951	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1952	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1953	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1954	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1955	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1956	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1957	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1958	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1959	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1960	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1961	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1962	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1963	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1964	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1965	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1966	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1967	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1968	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1969	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1970	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1971	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1972	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1973	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1974	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1975	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1976	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1977	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1978	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1979	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1980	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1981	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1982	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1983	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1984	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1985	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1986	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1987	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1988	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1989	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1990	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1991	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1992	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1993	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1994	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1995	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1996	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1997	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1998	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	1999	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1
Alamo	2000	22.8	1-12	10.2	1-12	12.6	11.5	1.1	1.1

Source: Information of most value was obtained from University of New Mexico, Albuquerque, New Mexico.

Computed from United States Weather Bureau, Bureau of Meteorology.

The use of data presented in table 7 may be illustrated by a consideration of those given for State College and San Marcial. The record for each of these two stations covers a period of 77 years. The annual precipitation during that time averaged 8.53 inches for State College and 9.10 inches for San Marcial, the standard deviation being 2.74 and 3.29 inches, respectively, for the two stations. That means that during approximately 62 percent of another 77-year period the annual precipitation is likely to fall within a range of one standard deviation below and one standard deviation above the mean annual precipitation for each of the two stations, i. e., between 5.79 and 11.27 inches at State College and between 4.83 and 13.39 inches at San Marcial. Since the range at San Marcial is 3.7 inches greater than that at State College, the annual precipitation at San Marcial may be said to be considerably more variable than at State College.

The standard deviation also provides another means of comparing the variability of the annual precipitation at the several stations for which data are given in table 7. The annual precipitation at Clifton, for example, may be said to be slightly more variable than that at Tucuman, since (1) the weather records for these two stations are equal in length—30 years each—and (2) the standard deviation for Clifton—3.26 inches—is a trifle greater than that for Tucuman—3.06 inches. Other weather stations given in table 7 which have records of approximately the same length may be roughly compared in like manner.

The annual precipitation in any particular part of the State is likely to vary greatly from year to year. Such variations at 8 representative weather stations during the 29-year period 1908-1937 are illustrated by figure 4. Thus the mean annual precipitation at Tucuman, Quay County, during that period was 16.50 inches. During those 29 years the annual precipitation was above the mean 14 times and below it 15 times. By observing the figure it will be seen that the annual may be above or below the mean at any of the 8 stations for 2, 3, and sometimes 4 years in succession. The greatest deviation from the mean generally occurs during years of heavy rainfall. The variation of the annual precipitation from the mean at any one of the 8 stations for each of the 29 years may be read roughly from the scale at the left of the figure.

The distribution of the annual precipitation during the year is a very important factor in New Mexico in the production of both range forage and irrigated crops. Figure 5 has been designed to show (1) the mean monthly precipitation at 9 weather stations located in different parts of the State and, (2) variations of the monthly from the mean monthly during a high and a low-rainfall year. The mean monthly precipitation at each of the 9 stations is indicated by the horizontal line, whereas the vertical bars show the actual monthly for both a low- and a high-rainfall year. These small charts, as well as table 7, show that most of the precipitation falls during the late spring.

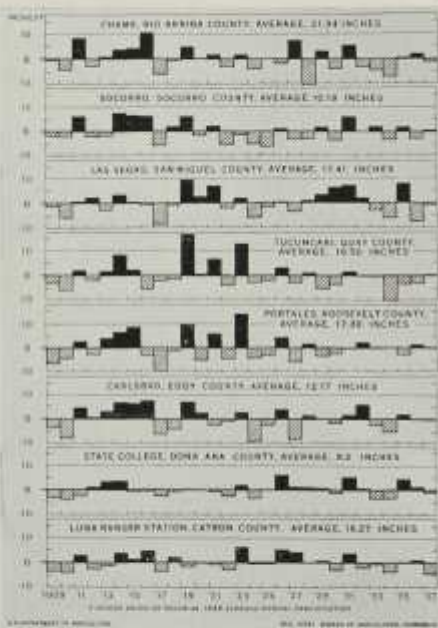


Fig. 4.—Precipitation anomalies of the period from the Frank average at a Weather Bureau station, 1928-1937, New Mexico.

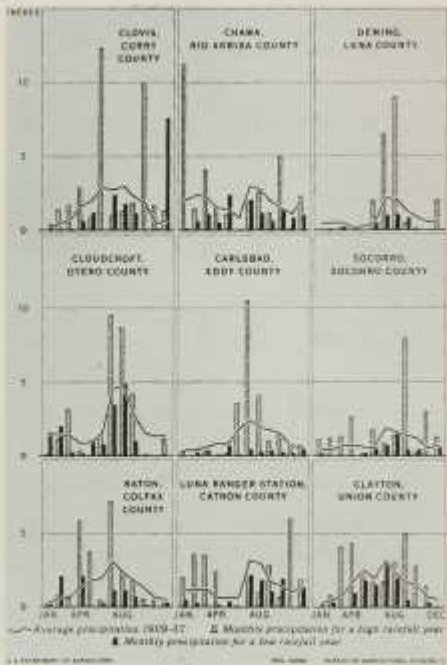


Fig. 2.—Precipitation, average monthly, and monthly for both a high and a low rainfall year at 9 Weather Bureau stations, New Mexico.

summer, and early autumn. In the northeastern part of the State, about 74 percent falls between April and September, inclusive; in the southeastern, about 69 percent; in the northwest, about 65 percent; and in the southwestern portion, approximately 60 percent. Very generally, though not universally, July and August are the high-rainfall months. This distribution of the annual precipitation is known as the Great Plains type of rainfall. It is best adapted to the production of summer pasturage and late-maturing crops, such as corn and the sorghums. The monthly precipitation, like the annual, varies greatly from year to year and wide departures above and below the normal are to be expected in any part of the State.

Another important characteristic of New Mexico climate is the marked tendency for the summer storms to be localized. One locality may receive a violent downpour of rain (sometimes of hail or rain and hail) while a short distance away no moisture at all may fall. Sometimes the local storm assumes "hoodlum" proportions. It is to be expected, therefore, that the annual precipitation will vary greatly within very short distances. Owing to the torrid character of many of the summer showers, the proportion of the total annual precipitation that may be absorbed and become available for the growing of cultivated crops and range forage is greatly reduced by surface runoff. In addition to the falling of much of the precipitation as violent showers, tight, compact soil conditions, rough surface relief, and a depleted vegetation cover also contribute to the loss of water by surface runoff.

Evaporation.—The adequacy of the annual precipitation for the production of both irrigated crops and range forage in New Mexico is reduced considerably each season by the evaporation of moisture from the surface of the ground. This is quite evident from the evaporation records kept at the field experiment station located at Tucuman, Queré County, during a 22-year period. During that time the evaporation that took place from a free water surface from April to September, inclusive, averaged 54.6 inches. That is approximately four and one-third times as much as the mean seasonal precipitation at Tucuman during the 22-year period. Fairly high day-time temperatures during the summer, a high percentage of days of sunshine, a low relative humidity, and an almost constant movement of the atmosphere are the principal factors which contribute to a rapid evaporation from the surface of the soil.

SOILS

New Mexico presents a wide variation in soil conditions and soil types. This is due chiefly to a relatively large variety of parent rock from which the soils of the State have been derived; to variations in the climatic conditions which have obtained during the soil-forming periods; to the manner in which the soils have been formed; and finally to variations in the age or maturity of the respective soil types. In some localities where the parent rock is but partially decomposed and broken down, it is covered by only a very thin layer of surface soil.

In other areas the soils are deep, well drained and productive, provided the rainfall is sufficient for profitable crop production or water is available for irrigation. In still other localities, where natural drainage is poor and where the surface soils carry a relatively high content of saline materials, limited areas have become seeped and sufficiently alkaline after irrigation has been practiced for a few years to be detrimental to the production of field crops. Such areas are to be found in places along the Rio Grande, the San Juan River, and other streams.

The soils of New Mexico may be arranged in four groups according to the topographic positions they occupy; that is, the mountainous and foothill areas; the high plains, plateaus, mesas, and flat-bottomed drainless basins; the escarpments, steeper slopes, and alluvial fans lying between the high plains, plateaus, and mesas, on the one hand, and the valley floors and the gently sloping alluvial fans on the other; and lastly, the valley floors and the gently sloping alluvial fans lying adjacent to the valley floors.

The mountain and foothill soils cover virtually all the lands lying within the borders of the several national forests; the foothill lands, most of which are wooded; the isolated sharp mountain ridges; other rough mountainous areas which are generally covered with brush; and also the grasslands which occupy some of the mountain valleys and parks; and the smoother, undulating undisturbed high ridges. The soils of this group are mostly loams and sandy loams, which are generally shallow and more or less stony. The mountain valley grassland soils are usually deeper, darker, and more productive than those of the rough timbered areas.

The soils of the second group, those occupying the mesas, plateaus, and high plains, cover a very large portion of the State. In nature they vary from coarse gravel and sand, at one extreme, to clay loams, clay, and adobe at the other. It is in this group of soils that practically all of the dry or nonirrigation farming of New Mexico is done. The silt loams and clay loams are best adapted to the production of the small grains. On the other hand, the sandy loams are better suited to row crops, such as corn, grain sorghum, and broomcorn. Over much of the area occupied by this group, the surface soils are shallow, the top layer of soil being underlain by caliche. The caliche varies in thickness from a few inches to many feet. In places it comes to the surface, the topsoil having been washed away.

The third group, the soils which occupy the slopes, alluvial fans, and escarpments, form more or less continuous long areas which are irregular in relief and broken here and there by erosion channels which contain the erratic deposition of colluvial material when side flash floods occur. The surface soils of this group are quite variable. They are usually gravelly and in places stony. Their moisture-holding capacity is generally low, owing to the porous gravelly material in the subsoil. Most of the lands occupied by this group are poorly adapted

to crop production, and for this reason have not been brought under cultivation.

The fourth group, that occupying the valley floors and the more poorly sloping alluvial fans, is very important from a crop-production point of view. This is because it contains a very high proportion of the irrigated lands of the State. The soils of this group are chiefly alluvial and to some extent volcanic. Much of the material occupying the valley floors has been transported long distances by water; some has been brought in by side washes and some has been deposited by the wind. The soils vary widely in texture, i. e., from coarse sand and gravel at one extreme to silt, silt loam, clay, clay loam, and silt loam at the other. They also vary greatly in depth, subsoil, natural drainage, freedom from saline materials, and in productivity.

TYPES OF NATURAL VEGETATION

A great diversity of vegetation types is to be found within the borders of New Mexico. This is due primarily to variations in elevation, precipitation, temperature, length of growing season, and soil. The variations in these factors and their influence have been discussed above. Figure 5 shows the location of the six vegetative type areas into which the State has been differentiated in this study, namely, semidesert shrub, semidesert grass, short grass, oak shrub, woodland, and forest. It also shows in black the location of the principal irrigated areas. These six vegetative types are briefly characterized below.

Semidesert Shrub.—The area occupied by semidesert shrub is very long range and is confined largely to the counties of Hidalgo, Luna, Dona Ana, Sierra, Socorro, Otero, and Eddy. The average rainfall is about 9 inches. The type covers the lower plains, mesas, and river valleys. It consists principally of *creosote bush* (*Quercus tridentata*), blackbrush (*Fouquieria serena*), mesquite (*Prosopis glandulosa*), soapwood (*Yucca elata*), and cholla (*Cylindropuntia setaceus*). Where the last-mentioned plant occurs in abundance, grazing capacity is high, compared with that of the remainder of the area, which is nearly worthless and which, on the average, requires over 150 acres to carry a cow year-long. Other shrubs common to this type are: *Juglans* (*Zycophus lycoides*), *acacia* (*Acacia constricta*), *ocotillo* (*Fouquieria splendens*), Spanish bayonet (*Yucca macrocarpa*), desert willow (*Chilopsis linearis*), threadleaf sage (*Artemisia filifolia*), and screw bean, locally known also as *manilla* (*Stromboscarpa pubescens*). The grasses of this type are those listed below for the semidesert grass type. Occasionally they may form extensive areas throughout the semidesert shrub. Soils are generally poor and shallow, being underlain with caliche, which helps account for a good deal of the unproductiveness of the type. Annual weeds are sometimes abundant in the spring.

Semidesert Grass.—This type is confined largely to San Juan, Bernalillo, Valencia, Grant, and the counties previously listed for semidesert shrub. Growing conditions (precipitation and temperature) are

also much the same as in the southwest shrub. The type consists of such valuable grasses, on the higher, drier plains and mesas, as: Black grama (*Bouteloua eriopoda*), the dropseeds (*Sporobolus* spp.), and bush sedge (*Muhlenbergia porteri*). Its grazing capacity varies from 20 to 60 acres per cow yearling. On flood flats and natural calcareous basins, toboggan grass (*Hilaria mutata*), alkali sarsaparilla (*Sporobolus airoides*), curatmesquite grass (*Panicum obtusum*), and burrgrass (*Scleropogon brevifolius*) are important as summer-fall feed. Browse may be scattered or may occasionally be predominant in the southwest grass type. The species are the same as those found in the southwest shrub type.

Short Grass.—As a whole, this type comprises the best range land in the State. Grazing may be carried on yearling. The type varies in grazing capacity from about 25 to 60 acres, with an average of about 45 acres per cow yearling. The principal range forage is blue grama (*Bouteloua gracilis*). Other common constituents are buffalo grass (*Buchloe dactyloides*) in the western counties, black grama, hairy grama (*Bouteloua hirsuta*), subulate grama (*Bouteloua subulata*), ringgrass (*Muhlenbergia torreyi*), a seedless species, salletta grass (*Hilaria juncea*), and three-awn (*Aristida longicoma*), hairy triodia (*Triodia pilosa*), and alkali sarsaparilla with annual weeds and small compound (*Yucca glauca*) in varying quantities. Considerable areas of the short-grass type have deteriorated, because of too heavy grazing, to the half-shrub type made up principally of mesquites (*Prosopis* spp.), with remnant species of grasses. It is good in grazing capacity and many stockmen complain that invasion of the plant in the spring causes abortion in cattle.

In eastern New Mexico the tall-grass type is common on loose sandy soils. As shown in figure 8, this is included within the short grass. No doubt at one time the tall grass was considerably more extensive than at present. Fire, overgrazing, and dry farming have undoubtedly transformed much of this into the short-grass type. The tall-grass type is composed chiefly of the following species: "Big bluestem" or keelgrass (*Andropogon furcatus*), "little bluestem" or prairie beardgrass (*Andropogon scoparius*), three-awn grasses (*Aristida* spp.), small compound, threadleaf sedge, and annual weeds. The grazing capacity of the tall-grass type is lower than that of the short-grass; however, stockmen regard it highly in drought years and during severe winters.

Oak Scrub.—This type is confined to southeastern New Mexico and is characterized by the low shrubby growth of shinny oak (*Quercus laevis*). Other plants characteristic of the oak brush type are those described above for the tall-grass-type. The grazing capacity of shinny oak area is generally estimated by stockmen at about half that of areas covered by the short grasses. Overstocking causes considerable losses some years from "shinny oak poisoning." However, this is not serious enough to preclude the grazing of livestock, since most of the poisoning takes place during a short period in the spring. Most losses can be prevented



Fig. 1.—Type of natural vegetation, Woven Woods.

by moving the cattle to grass ranges or by supplemental feeding of alfalfa hay.

Woodland.—This type is composed chiefly of pines (*Pinus edulis*), juniper (*Juniperus* sp.), and several of the evergreen oaks (*Quercus macrocarpa*, *Q. emoryi*, and *Q. pistata*). Range forage consists principally of blue grama, galleta grass, Texas timothy (*Cynosurus plectoides*), side-sata, hairy, and black grama; rough grasses (*Achillea* spp.), and such browse species as salsaparilla (*Atriplex* spp.), leasgrass (*Nolina microcarpa*), and willow (*Salix* spp.). The type occurs from about 5000 up to about 7500 feet. Annual precipitation varies from 12 to 15 inches. Grazing is possible, but years occur when death losses from severe

winter conditions are heavy. The average grazing capacity of the type is about 70 acres per cow yearling.

Forest.—The areas shown in Figure 6 as forests include approximately all lands above 7,000 feet elevation. Thus, beginning as this altitude, ponderosa or yellow pine (*Pinus ponderosa*) is the common timber species up to about 9,000 feet, where the type gives way to Douglas fir (*Pseudotsuga mucicola*), white fir (*Abies concolor*), and quaking aspen (*Populus tremuloides*), which go up to about 10,500 feet. In the upper limits Engelmann spruce (*Picea engelmannii*) is the common birdsey tree. Precipitation varies from 15 to 25 inches or more annually and the frost-free grazing season decreases markedly with increase in altitude, so that in the small areas above timber line (about 11,000 feet) it is less than 90 days. On a yearling basis, about 90 acres are required per cow in the lowest type. This is used for grazing, however, only during the summer and early fall months.

Range forage species are: Blue grama in the lower altitudinal limits, which gives way quickly to such bunch grasses as Arizona bunch or pinegrass (*Festuca arizonica*), mountain rye (*Stipa montana*), headless pinegrass (*Stipa tenuifolia*), and various weeds. Common browse species are: mountain mahogany (*Cercocarpus montanus*), wild currants (*Ribes* spp.), antelope brush (*Parthenocissus*), thimbleberry (*Rubus parviflorus*), and willow. The last-mentioned plant occurs in stunted form on the highest mountain peaks, which, in general, are covered only with such grasslike vegetation as the sedges (*Carex* spp.) and rushes (*Juncus* spp.).

BIOLOGICAL FACTORS

Although the biological factors have played but a minor part in the development of the agriculture of New Mexico, they give rise, nevertheless, to various expenses, losses, and inconveniences that must be borne by the farmer and ranchman of the State. These factors naturally fall into six general groups, namely, (1) animal diseases, (2) plant diseases, (3) insect pests and internal parasites, (4) rodents and predatory animals, (5) weeds, and (6) plant adaptation. Brief discussions of each of these six groups follow.

ANIMAL DISEASES

The following are the more important of the animal diseases: blackleg, a rapidly developing fatal disease of young cattle that is controlled by the administration of vaccines; hemorrhagic septicaemia, an infectious disease of both cattle and sheep that is combated by preventive measures; lumpy jaw (actinomycosis) of cattle; calf diptheria, which sometimes affects cattle as old as two years; garget (mastitis), or infection of the udder of cows; pinkeye and cancer eye of cattle; Bang's disease (indolent abortion); scrapie of range cattle and sheep; blue bag (malignant mastitis) of cows; encephalomyelitis (sleeping sickness) and distemper of horses; and pneumonia and cholera of hogs. A fairly complete list of animal diseases and ills and their first-aid treatment may be found in New Mexico Agricultural Extension Service Circular No. 153, "Common Ailments and First-Aid Treatment of Livestock."

PLANT DISEASES

The following are some of the more important plant diseases: root rot, which affects many plants, such as cotton, alfalfa, sorghum, apples, cherries, and peaches; the bacterial blights of alfalfa, irrigated beans, tomatoes, and potatoes; potato psyllid yellows; fusarium wilt of chili peppers and potatoes; rhizoctonia of potatoes; verticillium wilt of cotton and tomatoes; black rot of sweet potatoes; black rot and blackleg of cabbage; angular leaf spot of cotton; corky top of beans and tomatoes; peach mosaic; corn smut and rust; and striking smut of wheat. Nematodes also sometimes cause serious damage.

INSECT BEETS AND INTERNAL PARASITES

The grasshopper, feeding moth, potato psyllid, potato flea beetle, onion thrips, cutworm (larva worm), aphids of practically all crops, Mexican bean beetle, corn ear worm, sawworm, skin lice of all domestic animals; mange or wash mites of cattle, sheep, horses, and hogs; sheep ticks; galls in the head of sheep; and the botfly of the horse are rated among the most damaging insects to crop and livestock production in New Mexico. Likewise, tape and stomach worms of sheep and roundworms of hogs are of greatest importance among the internal parasites.

ROBENTS AND PREDATORY ANIMALS

Rabbits, prairie dogs, kangaroo rats, and gophers are considered the most destructive rodents of the State. The following statement gives some idea of their importance: "Observation has shown that in an average poor year of precipitation an average range land rodent . . . will consume about 20 percent of the grass forage produced. Moreover, on seriously depleted range lands, rodents alone can prevent the restoration of those lands to their former productivity." The chief damage done by gophers is interference with irrigation through burrowing into ditches.

Coyotes and bobcats are the chief killers among the predatory animals. Mountain lions, bears, and weasels (especially the latter) are not numerous and, for that reason, are minor offenders. The predatory animals generally prey upon the livestock being run on the national forests and on other high, rough ranges. While lambs and grown sheep are attacked most frequently, some calves and colts are also lost. A coyote or a bobcat, during its lifetime, kills an average of approximately

— K. W. Parker, formerly Assistant Animal Husbandman, New Mexico Experiment Station, in an unpublished paper entitled "Range Conditions in New Mexico, Based on Types of Vegetation and Grazing History."

\$2500 worth of livestock as contrasted with about \$1,000.00 for a mountain lion or a wolf and about \$500 for a livestock-killing bear. But few bears become killers of livestock. Since coyotes destroy many rabbits and other rodents and kill few calves, some New Mexico cattlemen consider them more beneficial than detrimental to the range cattle industry.

WEEDS

The weeds of New Mexico may be grouped into three classes, namely, annuals, biennials, and perennials. Since they present the more serious problems, only the perennials will be considered in this discussion.

The perennial weeds fall naturally into two groups. The members of one group have underground rootstocks and most of them produce seed. Thus, some of them reproduce by means of both seed and root-stalks, while others spread only by rootstalks. This group of perennials infests ditchbanks, irrigated crop and pasture land, and also moist non-irrigated land. The more important species of this group are bindweed, or wild morning-glory (*Convolvulus arvensis*), Johnson grass (*Sorghum halepense*), Russian knapweed (*Centaurea* sp.), whitetop (*Lepidium draba*), silvertop povertyweed (*Trifolium discolor*), nut grass (*Cyperus esculentus*), and lilacweed (*Helianthus filifolius*).

The other group of perennial weeds is made up of such poisonous plants as the locoweeds (*Astragalus* spp. and *Oxytropis lamberti*); milk-weeds (*Acletois* spp.); various poleweeds (*Atriplex heterophylla*); larkspurs (*Delphinium* spp.); juniper (*Artemisia tridentata*); lupines (*Lupinus* spp.); death rattles (*Zygadenus* spp.); and woody aster (*Xylorhiza parryi*). In addition to the perennials listed above there are also some poisonous annuals. For example, *Drymonia* (*Drymonia pachyphylla*) is a very poisonous annual.

These poisonous plants are very widely distributed, their infestation varying from heavy in some localities to quite light or none in other places. Some plants are poisonous to both sheep and cattle, others only to cattle, and still others only to sheep. Most poisonous plants are not relished by livestock and are seldom eaten except when there is a scarcity of palatable forage. Estimates of the annual loss of range livestock attributable to the eating of poisonous plants range from 5 to 10 percent of the total livestock population.

PLANT ADAPTATION

Plant adaptation has played a very important part in the development of the agriculture of New Mexico. A few illustrations will make clear this point: Shallow-soiled, low growing nutritious grasses predominate in much of the eastern portion of the State where the soils are both shallow and of fine texture. These grasses make their growth during the summer months (that is, during the rainy season), cure while standing, and may be grazed during any month of the year except when the surface of the ground is covered with a deep mantle of snow. The

full deep-rooted grasses, on the other hand, predominate on the deep, sandy soils. Cattle is well adapted to the soil and climatic conditions of the irrigated valleys of the southern parts of the State, and when introduced, practically revolutionized the cropping systems of the Mesilla and Pecos Valleys. Chama, waterfret (*Lernaea lanata*), and black grama are excellent examples of forage-producing plants adapted to the semiarid conditions of southern New Mexico.

ECONOMIC FACTORS

Economic factors have played an important part in the development of agricultural conditions and in the various types of farming which prevail in the different parts of New Mexico at the present time. In general the farmers and ranchmen of the State have endeavored to obtain maximum returns from the use of the land, equipment, and labor available to them as individuals. This involves the selection and combination of crop and livestock enterprises and the development of cultural and managerial methods and practices which seem likely to give the largest future returns. In some instances the necessity of supporting farm families on tracts of land (mostly homestead units) that are too small to be used as stock ranches has caused land to be brought under cultivation and used for crop production that is best suited to the grazing of livestock. In other cases the low incomes of small stock ranches and farms of other types also have caused the overstocking of the available grazing lands, the expected income from livestock being measured, in large part, by the number of animals grazed.

ACCESS TO MARKET

A large percentage of the surplus products of the State must be transported long distances in order to reach the more densely populated consuming centers. This handicap is being met, in part, by producing concentrated products which have relatively high value per unit of weight, such as cattle, sheep, wool, cotton, wheat, dry beans, and alfalfa seed. Livestock and crop products of this sort can be shipped long distances with little or no deterioration in quality.

TRANSPORTATION

The construction and operation of the railroads and improved highways of New Mexico have played an important role in the agricultural development of the State. Cash crops are now produced for distant markets in several of the isolated irrigated and dry-farming districts. The highways and auto trucks have tremendously increased and widened the markets for such perishables as fruits, vegetables, and dairy products. Likewise, they have materially augmented the areas in which products of this sort may now be produced.

COMPETITION

Competition among enterprises for the use of land on the individual farms and ranches of New Mexico has had much to do with determining what crops are grown, what kind of livestock is produced, and what types of farming and ranching have developed in different parts of the State. In other words, farm and ranch operators have endeavored as to utilize their land, water, equipment, and labor as to obtain maximum returns. Unlike the process of trial and error, some enterprises have increased in importance, while others have decreased. For example, alfalfa occupied two-thirds of all cropland in the Elephant Butte Irrigation Project in 1915. Cotton was introduced in 1916 and by 1925 the cotton acreage made up two-thirds of all the cropland in the project, while that of alfalfa had declined to about one-fifth of the total. Thus, the introduction of new enterprises, as shifts in relative prices of products or in costs of production, result in continual changes in the relative comparative advantage of the various enterprises.

IMPROVED MACHINERY AND IMPLEMENTS

The development and introduction of such machinery and implements as the tractor, combined harrow, threshing, six-way disk plow, press drill, and duckfoot cultivator have (1) greatly influenced the pushing of dry farming westward into New Mexico, (2) materially increased the amount of land that one man can farm efficiently, and (3) reduced the cost of crop production, especially the cost of producing wheat.

MAJOR AGRICULTURAL AND ADJUSTMENT PROBLEMS

Like other States of the western Great Plains and the Rocky Mountain region, New Mexico is beset with numerous agricultural problems, the solution of which will require many adjustments. Some of these problems are intimately related. For example, the adjustment of livestock numbers to the carrying capacity of grazing lands is closely related to the problems of maintaining, improving, or restoring the natural vegetative cover and of controlling both wind and water erosion. The solution of any one of these three problems would have a direct bearing on the solution of the other two. In like manner the problem of enabling the rural people of north central New Mexico in their present condition on the irrigated lands to obtain an adequate living from these available resources is also closely related to the problems of (1) increasing and stabilizing the supply of irrigation water; (2) efficiently using the water that now is or may be made available; and (3) increasing the size of the extremely small farms until they are large enough to support properly the families thereon. Only a few of the major problems of the State will be considered here.

LAND-TAX ADJUSTMENTS

Adjustments in the use of land pertain very largely to localities within the State (chiefly the eastern portion) where attempts are being

made to produce crops by dry-farming methods and whose experience has shown that much land has been brought under cultivation which should have been left in its native vegetation and used only for grazing purposes. The variability of the scant annual precipitation and its erratic distribution throughout the year render unscrupulous dry farming hazardous in almost all parts of the State, even on the best of soils. Furthermore, much of the land which has been put under cultivation is too shallow, too coarse, or too light in texture to produce crops successfully without irrigation. The problem is to divert the use of such land from the growing of field crops to the production of grazing forage. This involves the restoration of the native vegetative cover or the establishment of a new plant cover that is satisfactory for grazing purposes.

Since the farms of all other types are too small to be converted into economically operated stock ranches, the problem also involves the consolidation of farms and the conversion of displaced into grazing land. However, the re-establishment of a satisfactory vegetative cover on land that has been farmed for several years is generally both difficult and expensive. If the consolidation program is undertaken, the problem also involves providing means by which the people removed from the farms to be consolidated may earn a living. If this is not done, more harm than good may result from the attempted adjustment.

OVERSTOCKING THE GRAZING LANDS

The carrying capacity of much of the grazing land of New Mexico has been materially reduced by years of overstocking. While excessive stocking is widespread, especially on the grazing lands of virtually all crop farms and small stock ranches, grazing lands are to be found here and there now which individual stockmen have had control and which have been managed efficiently with the view of maintaining the vegetative cover.

The principal results of excessive stocking have been: (1) a weakening or deterioration of the vegetative cover, a decrease in the number of palatable and nutritious plants, and an increase in unpalatable and less desirable ones; (2) an increase in both wind and water erosion; and (3) a decrease—where the overstocking is excessive—in both the quality and total pounds of livestock produced.

The principal causes for excessive stocking have been: (1) competition in the use of the unregulated public, State, and privately owned grazing lands, the prevailing idea having been to get the grass before the other fellow gets it and to keep it grazed so closely that when stock will not be brought in; (2) stocking on the basis of the amount of forage produced during the better years, which results in excessive stocking during years of drought; (3) a lack of knowledge on the part of many livestock producers that, as animal nutrition, the feed consumed is first used for maintenance, that only after maintenance has been taken care of can there be any increase in weight, and that it is possible to stock so heavily



Fig. 2.—Natural watersheds, irrigated areas, and water districts of New Mexico.

that all the feed will be used for maintenance; (4) an adequate supply of water and watering places; and (5) a good distribution of the watering places, which results in excessive grazing near the watering places and undergrazing at considerable distances therefrom.

The principal objectives in adjusting livestock numbers to grazing feed resources are: (1) to improve the natural vegetative cover which, in turn, increases the carrying capacity of the grazing lands and also decreases both wind and water erosion; and (2) to increase the total weight of the livestock to be produced. The second objective may be obtained by increasing the quantity of forage produced and by decreasing livestock numbers until there will be sufficient feed for both maintenance and increase in weight.

SOIL CONSERVATION

Soil conservation has become a pressing problem over much of New Mexico. In all parts of the State where dry farming is practiced, soils which have produced crops for a few years are subject to blowing when left bare and exposed to high winds. The land is also subject to water erosion when heavy local showers occur, especially if left comparatively smooth and unprotected by a vegetative cover. Where there is considerable slope to the surface and if the vegetative cover has been weakened or destroyed by excessive grazing, the soils of the grazing lands are likewise subject to both wind and water erosion. In many of the high irrigated valleys, the slope of the surface of the land is sufficient to cause a great deal of washing under the present methods used in applying irrigation water. Irrigated lands also are sometimes severely damaged by flash floods which rush down the side ravines and deposit sand, gravel, and stones on fields.

The conservation of the soil under the conditions of dry farming described above depends largely on the retention and absorption of most of the precipitation where it falls and also on the use of effective means of reducing both wind and water erosion. A vegetative cover and the residue of crops and weeds left on the surface of the ground tend to hold the moisture where it falls and also to lessen materially both wind and water erosion. Strip farming and contour listing have proved to be effective means of retaining moisture where it falls, preventing surface runoff and the washing and drifting of the soil. In some cases the conservation of the soil will require the shifting of its use from crop production to grazing. The most effective means of conserving the soil of grazing lands is the cessation and maintenance of a substantial vegetative cover. In most cases this may be accomplished, as indicated above, by properly lowering the rate of stocking. The possession of water rights in the high irrigated valleys will require a modification of the methods used in applying the water. In order to prevent the deposition of debris on the irrigated fields it will be necessary in most cases to construct adequate channels to carry the floodwaters across the fields to the streams below.

STABILIZATION OF THE SUPPLY OF IRRIGATION WATER

The stabilization of the supply of irrigation water in New Mexico has become a pressing necessity. This is largely because the available supply of water in many districts is not under adequate control as to storage and distribution to obtain a relatively high degree of efficiency in the use of water. While storage facilities have been provided for the larger districts, most of the smaller ones are irrigated by diverting water directly from the streams during the irrigation season. In many cases the diversion dams are temporary and are washed out from time to time. The construction of adequate, permanent diversion dams on the streams, where it is feasible, would be a material improvement. The construction of storage reservoirs for impounding the water that flows

down the streams unused during the reirrigation season would aid materially in stabilizing the water supply of many of the smaller districts. It is rather certain, however, that the construction of a series of reservoirs on the upper streams for the relief of the smaller irrigated districts would bring on serious litigation as to rights to the use of the water.

The adjustment of the acreage of land under cultivation to the supply of subterranean water in the pump-irrigated districts of the State is another problem that is likely to become more pressing as developments advance. The tendency (except where the lift is great and the cost of pumping excessive) has been to bring so much land under irrigation that the water is pumped out of the subterranean reservoir faster than it flows in. In this way the water table is lowered, the lift and the cost of pumping increased, and the profits of farming decreased. The problem is to keep the amount of land under cultivation properly adjusted to the underground supply of water.

EFFICIENT USE OF IRRIGATION WATER

The efficient use of water is highly important in all irrigated districts within the State. This is especially true in the north central part of New Mexico where the rural population is densely crowded upon the irrigated land and where a shortage of irrigation water is sometimes experienced owing to the lack of storage facilities. On many farms in different parts of the State water is allowed to flow relatively long distances across the fields, parts of the land becoming saturated and other parts being under-irrigated. In other places, especially in mountain valleys, considerable erosion takes place where the slope of the land is sometimes 75 to 100 percent greater than it should be for the irrigation methods now being used. The solution of this problem, in many cases, will require material changes in the methods and rates of applying water. Furthermore, many irrigators are greatly in need of instruction as to how to apply irrigation water more evenly and effectively.

DRAINAGE OF IRRIGATED LANDS

Soil or land drainage problems develop in practically all gravity irrigated districts. If adequate drainage systems are provided sufficiently early, the accumulation of saline materials in quantities harmful to the growth of field crops is generally prevented. On the other hand, if this is not done, drainage problems usually arise. A few of the older irrigated districts of New Mexico have been neglected and allowed to become warped and impregnated with harmful salts. The reclamation of these districts has now become an expensive undertaking.

SIZE OF FARM AND LOW INCOME PROBLEM

The small-farm or low-income problem in New Mexico is acute. Of the 21,494 farms and ranches in the State in 1928, approximately

4,000 or about 13 percent of the total number, contained less than 10 acres per farm, and 8,300 or about 27 percent, contained less than 20 acres. If considered from the standpoint of receipts, it may be said that 1670 of the total number had gross incomes of less than \$250 per farm, and that 9,950 had gross incomes of less than \$400. Especially is the small farm, low-income problem acute in the north-central part of the State where the Spanish-speaking people are concentrated, chiefly on the irrigated lands, and where it has been the custom for some 300 years to divide the family landholdings equally among the children upon the death of the parents. It may be said, also, that a large percentage of all nonirrigated farms and a good many stock farms and ranches are too small (1) to be operated economically, and (2) to provide sufficient income to support a family properly.

There are two phases in the solution of this problem: One involves the consolidation of farms and ranches, and also the redistribution of grazing lands, in order to have units that can be operated efficiently and which will yield sufficient income to support a family. This phase, further, involves the shifting of land to its proper use. The second phase of the problem is concerned with the future welfare of the people now living on the farms and ranches to be consolidated. The human aspect of this problem should be foremost in the minds of those charged with this twofold responsibility.

GEOGRAPHY OF THE AGRICULTURE OF NEW MEXICO

The purpose of this section is to show the geographical distribution and relative importance of (1) the leading crops grown in New Mexico; (2) the different kinds of livestock produced; and (3) the more important types of land which the farms of the State have been classified. This is done by a series of dot maps, figures 9-30. The position of the dots in the figures shows distribution for seven years and their number indicates relative importance. Variations in surface relief, climate, soils, and the availability of water for irrigation have had much to do with determining what and where crops are grown.

New Mexico contains approximately 78,400,000 acres of land (table 5). In 1929, 99 percent of the total area was in farms and ranches. The land not in farms and ranches (47,519,220 acres) was used chiefly for grazing purposes, national forests, national parks, national monuments, Indian reservations and allotments, military reserves, mining, railroads, highways, residences, and industrial and business locations. Of the 86,622,254 acres in farms and ranches in 1929, 92 percent was grazing land, 6 percent cropland, and 2 percent waste or other land. Because of the low percentage of the total land area that is cropland (approximately 2½ percent), a very uneven distribution of bulk crops and types of farming is to be expected.

Owing to a great dearth of county and precinct data, it was necessary to use those given in the 1930 U. S. Census of Agriculture in preparing figures 9 to 30. The data presented in the 1932 census could not be

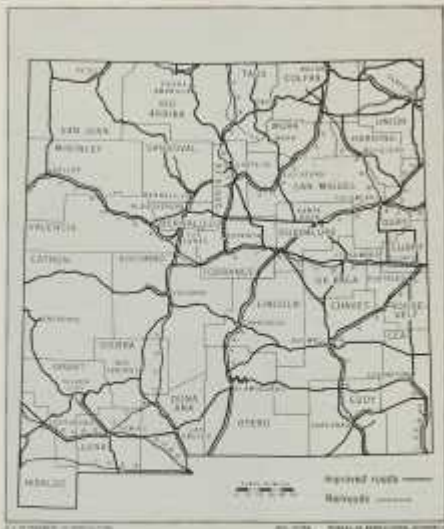


Fig. 1.—Chicoma, improved highways, and railroads of New Mexico.

used, because the severe drought of 1934 materially reduced livestock numbers and the harvest of crops.

DISTRIBUTION OF CROPS

The most important crops, measured in thousands of acres harvested during the 10-year period 1927-1936, ranked as follows: grain sorghum, 280; all wheat, 236; corn, 210; all hay, 179; dry beans, 154; cotton, 110; broomcorn, 41; oats, 20; barley, 7; alfalfa seed, 3.4; and truck crops, 2.7. Of the total average acreage of hay harvested during the 10-year



FIG. 5.—Cotton acreage harvested in 1929.

period, alfalfa made up 92 thousand acres; wild hay, 25; small grains, 19; timothy and clover, 9; and miscellaneous crops, 16. Figures 9 to 14 present the distribution of the 6 leading crops, each dot representing 200 acres. The number of dots in each figure shows the acreage harvested in 1929 and the location of the dots indicates the distribution of the harvested acreage during recent years.

COTTON

The distribution of the acreage of cotton produced in New Mexico in 1929 is presented in figure 5, each dot representing 200 acres. Approximately 92 percent of the cotton acreage is located in the southern part of the State under irrigation, chiefly in the valleys of the Rio



Fig. 15.—Dry bean acreage harvested in 1929.

Garden and Pecos River. Measured by the comparative area of the respective crops harvested, cotton ranked considerably below the grain sorghums, wheat, corn, or dry beans. But because of the high yield obtained under irrigation, cotton is more important than the harvested acreage indicates. About 92 percent of the crop is grown under irrigation and 8 percent without irrigation.

DRY BEANS

The dry bean crop of New Mexico is produced mostly in the northwestern quarter of the State, the greatest concentration of the crop being near the central portion in Torrance County (figure 15). Approximately 92 percent of the 1929 crop was produced without irrigation and 8



Fig. 11.—All wheat, average harvested in 1929.

percent with irrigation. Under dry-farming conditions, dry beans may compete with corn, the grass sorghums, or wheat. Very frequently beans have been grown continuously on the same land, which has contributed materially to both acid and water wastes.

ALL WHEAT

The distribution of all wheat harvested in New Mexico in 1929 is shown in figure 11. The greatest concentration that year was in Curry and Quay Counties in the east-central part of the State. Considerable concentration occurred also in the southeastern part, especially in Harding County, and in the upper half of the Rio Grande Valley. Of the total average of wheat harvested, 92 percent was grown without irriga-



Fig. 1. Irrigated areas in New Mexico, 1915.

100 and 4 percent with irrigation. Approximately 91 percent of the 203,000 acres of wheat harvested in 1935 was winter wheat and 9 percent spring wheat. Recurring droughts affect the acreage of this crop which is harvested in the dry-farming sections of the State.

ALL CROPS

The growing of grain and forage crops in New Mexico is confined largely to the eastern tier of counties, the greatest concentration of the crop being in Curry County (Figure 12). In 1929, approximately 125,000 acres were harvested for grain and 150,000 acres for hay, fodder, and silage. That year about 93 percent of the total acreage was grown without irrigation and 7 percent under irrigation. Owing to seasons of



Fig. 12.—Corn, acreage harvested in 1925.

though, the proportion of the sorghum crop that is used for grain and for forage varies greatly from year to year. Measured by the harvested average, the sorghums lead all other crops in New Mexico.

CORN FOR ALL PURPOSES

Corn is the most widely distributed of all the crops grown in New Mexico. Its greatest concentration occurs in the east central and north-eastern parts of the State where dry farming is practiced. Some concentration of corn also occurs in the irrigated districts (figure 13). This crop, it will be noted, is grown in every county of the State and in practically all irrigated districts. In terms of harvested average during



Fig. 14.—Alfalfa and bromcorn acreage harvested in 1929.

the 1927-1936 period, corn ranked third, the average for the period being 219,000 acres. In 1929, approximately 83 percent of the crop was grown without and 17 percent with irrigation. Corn is grown in much the same way and under much the same conditions as the sorghums.

ALFALFA AND BROMCORN

The distribution of both alfalfa and bromcorn is shown in figure 14, the bromcorn being confined to the eastern tier of counties and the alfalfa almost entirely to the irrigated districts.

Of the total harvested acreage of all hay crops in 1929, nearly 50 percent was alfalfa. About 95 percent of the alfalfa crop that year was irrigated. In 1931, approximately 91 percent of the alfalfa crop was

used for hay and 9 percent for seed. While much of the alfalfa hay is used locally where produced, some of it is baled and shipped out of the State.

The bromegrass is grown as a cash crop and is produced in much the same way as oats and sorghum.

DISTRIBUTION OF LIVESTOCK ENTERPRISES

The production of range cattle and sheep occupies a very important place in the agriculture of New Mexico, the other kinds of livestock being of minor importance. This is because of the scant and erratic annual precipitation over most of the State, which makes nonirrigation farming hazardous even under the most favorable conditions, and also because of the low proportion of the total land area that can be put under irrigation.

The distribution of the different kinds of livestock produced within the State is presented in figures 13 to 22. The data in the figures indicate the amount of livestock on farms and ranches on April 1, 1930, while the location of the dots shows the distribution of livestock during recent years. A brief discussion accompanies each of the figures.



FIG. 15.—Cows and heifers two 2 years old kept mainly for beef production, based on census and census for April 1, 1930.

BEEF CATTLE

Range beef-cattle production is the leading livestock industry in New Mexico. As a rule, yearling grazing is practiced and very little wintering and fattening of cattle is done within the State. However, the range locale is sometimes supplemented by confinement-cake feeding.

On April 1, 1930, there were approximately 1,060,000 head of cattle on the farms, ranches, and grazing lands of New Mexico. Of the total number, 57,000 were cows and heifers kept mainly for milk production. Figure 15 presents the distribution of beef cattle, in terms of cows and heifers two years old kept mainly for beef production, each dot represent-



Fig. 16.—Sheep and lands, counties in 1930, and January-April 1, 1930.

ing 100 head. While beef cattle are distributed over all the State, there are two areas of marked concentration, the eastern and the southwestern parts of the State. In these two areas cattle are of far more importance than sheep. Most of the cattle produced are shipped as calves or short yearlings to distant feed lots to be finished for market.

SHEEP AND LANDS

The distribution of the 2,291,000 head of sheep and lands in New Mexico on April 1, 1930, is shown in figure 16, each dot representing 500 head. In the northwestern part of the State, sheep are evenly distributed and of far more importance than cattle. In other parts, especially the southwestern portion, there are very few sheep.



Fig. 27.—Goats and kids on farms and ranches April 1, 1930.

The Rambouillets strongly predominate in the ranges of New Mexico, about 90 percent of the lambs being straight Rambouillets. New Mexico breeders have made considerable progress in their efforts to develop an ideal range type of Rambouillet, *i. e.*, one in which the lambs are self-sufficing and the fiber is not below 61's in fineness and is of good crimping length—at least 2.25 inches.

GOATS AND KIDS

Goats and kids on the farms and ranches of New Mexico April 1, 1930, numbered approximately 200,000 head. Their distribution over the State, as shown in figure 27, was very uneven, since some counties had few or none of them. The following are some of the reasons that



Fig. 10.—Hog and pig farms in New Mexico, April 1, 1930.

goats are raised; they are used for meat, because they remain in fairly good condition during the winter and spring when sheep are generally thin in flesh; they eat certain types of food (chiefly browse) that cattle and sheep do not consume advantageously; and they produce both milk and mohair.

SWINE

On April 1, 1930, there were approximately 96,000 hogs in New Mexico. Of this number, 7,000 were sows and gilts that farrowed between January 1 and June 1, 1930; 25,000 were pigs born between January 1 and April 1, 1930; and 64,000 were other hogs born before January 1, 1930. Their distribution over the State is presented in figure 10.



Fig. 19.—Hogs raised during 1929.

each dot representing 100 head. That year about 50 percent of all hogs were in the dry-farming counties in the eastern part of the State, while most of the remaining 50 percent were in the irrigated districts. Hog numbers have increased during recent years, reaching about 85,000 by January 1, 1939. Corn is the principal feed used in finishing hogs for slaughter.

DAIRY CATTLE

In round numbers, 65,000 cows and heifers were milked in New Mexico during 1929. Of that number, 17,000, or 27 percent, were of dual-purpose breeding. The cows and heifers milked, as shown by figure 19, had much the same distribution as that of hogs. That year,



Fig. 20.—Chickens over 3 months old, number on farms and ranches April 1, 1930.

53 percent were in the dry-farming counties of the eastern portion of the State. Most of the remainder were in the irrigated districts, the greatest concentration being on the irrigated farms which supply the cities of El Paso, Albuquerque, Roswell, and Las Vegas with milk. Each dot in figure 19 represents 100 head.

CHICKENS

The distribution of 961,000 chickens over 3 months old reported on the farms and ranches of New Mexico April 1, 1930, is shown in figure 20, each dot representing 1,000. The greatest concentration, like that of hogs and milk cows, occurred in the dry-farming counties of the eastern part of the State and in the irrigated districts. That year (1930),



Fig. 21—Turkeys raised in 1929.

67 percent of the farms reported having chickens, the average being 45 per farm reporting. The bulk of the poultry and poultry products is produced on farms where the chicken enterprise is carried on as a side line.

TURKEYS

The production of turkeys in New Mexico is a minor enterprise. Approximately 14 percent of all farms reported raising them in 1929, the average number raised per farm being 29. The distribution of the turkeys raised that year is shown in figure 21, each dot in the figure representing 100. The distribution is very much like that of chickens.



Fig. 22.—Horses and mules on farms and ranches April 1, 1930.

HORSES AND MULES

The distribution of the 130,000 horses and mules on farms April 1, 1930, and born before January 1, 1930, is presented in figure 22, one dot representing 100 head. That year they were distributed more evenly over the State than any other class of livestock. In addition to the horses and mules, approximately 23,000 mules and mule colts were reported. Seventy-two percent of the farms of the State reported horses and (or) mules, the average per farm being 7 head. The number of horses, mules, and colts has been decreasing steadily for several years. For example, the estimated number of all horses, mules, and colts decreased from 221,000 in 1925 to 142,000 by January 1, 1929. Horses are used both as work animals and as saddle horses.

DISTRIBUTION OF FARMS BY TYPE

In 1929 there were 31,404 farms and ranches in New Mexico, according to the 18th United States Census of Agriculture. Because of incompleteness of the schedules, 2,009 had to be discarded. The remaining 29,395 farms and ranches were classified into types, the principal basis of the classification being the percentage of the gross receipts that was derived from different sources. The geographical distribution of the 5 leading types is presented in figures 23-28, each dot in the figures representing 3 farms. The data used in preparing these figures gave the number of farms and ranches in each rating precinct.

In considering these figures it should be understood that the classification of the farms of the State into types is not fixed. Shifts in the prices which farmers receive, in the acreage of crops grown, and in the amount of livestock produced from year to year are likely to cause corresponding shifts in the classification of at least a portion of the farms. Therefore, the picture presented by these seven figures should be looked upon as subject to at least minor changes from year to year.



Fig. 23.—Stock farms and ranches: number, types, and geographical distribution in 1929.

STOCK FARMS AND RANCHES

The distribution of the type, stock farms and ranches, is shown in figure 23. This type, it is to be remembered, is a consolidation of the two types, animal-specialty and stock-ranch, as classified by the United States Bureau of the Census. This consolidational type in 1929 constituted 23 percent of all the farms and ranches in New Mexico, 5,986 being stock ranches and 639 animal-specialty or stock farms. It is more evenly and widely distributed over the State than any other type. The wide distribution is due, of course, to the very high percentage of the total land area of New Mexico that is used for grazing purposes. Cattle, sheep, and wool are the chief sources of income on the farms and ranches of this type.



Fig. 24.—Geographical distribution and geographical distribution in 1929.

CROP-SPECIALTY FARMS

In 1929, the crop-specialty farms were secured, numerically, in the portions in New Mexico, numbering 4,291 that year. The farms of this type are distributed very unevenly, as indicated by figure 24. The greatest concentration of the farms in this class occurs in western Torrance and eastern Bernalillo Counties near the center of the State. This is a dry farming area, dry beans being the principal crop grown. An area of considerable concentration, also near the central part of the State, lies along the Rio Grande in Sandoval, Bernalillo, and Valencia Counties. The more important of the special crops from which at least 40 percent of the gross income must be derived in order that the farms may be classified as crop-specialty in New Mexico are: dry beans, hay, sweet potatoes, peanuts, potatoes, and alfalfa seed.



Fig. 25.—Geographical distribution of cash-grain farms in 1929.

CASH-GRAIN FARMS

The cash-grain farms in New Mexico in 1929 numbered 2,942 and made up approximately 10 percent of all of the farms within the State. About 50 percent of them are located in three counties in the east central part, where crops are grown by dry-farming methods. Another 20 percent are in four counties along the Rio Grande near the coast of the State. The latter group are irrigated farms. The principal crops produced on the farms of this type are the grain sorghums, wheat, corn, and smaller acreages of oats and barley. Wheat and the grain sorghums are the chief cash-grain crops. Figure 25 illustrates the geographical distribution of the cash-grain farms.



The distribution of general farms: number and geographical distribution in 1929.

GENERAL FARMS

Numerically, the general farms ranked fourth, with 3,305 in this type in 1929, which was a little more than 11 percent of all farms in New Mexico that year. The general farms, like the cash-grain and crop-specialty farms, are unevenly distributed over the State (figure 26). The areas of densest concentration are located along the Rio Grande in Valencia, Bernalillo, and Rio Arriba Counties, where all farms are irrigated. Under dry-farming conditions, most of the general farms are in the east central and northeastern counties. The income of the farms of this type is generally derived from a variety of sources and is more evenly distributed than that of any other type, the proportion in 1929 being approximately as follows: from crops, 41 percent; livestock, 19; livestock products, 21; forest products, 1; and farm products used by the operator's family, 18 percent.



Fig. 27.—Cotton farms: number and geographical distribution in 1929.

COTTON FARMS

The geographical distribution of the 2,573 cotton farms in New Mexico in 1929 is shown in figure 27. Cotton farms that year strongly predominated in two areas, namely, along the Rio Grande in Dona Ana and Sierra Counties and along the Pecos River in Chaves and Eddy Counties. All of the cotton grown in these two areas is produced under irrigation. There are also these other small irrigated cotton-producing areas, one each in the counties of Otero, Luna, and Hidalgo. Figure 27 further shows the location of approximately 100 cotton farms in the dry-farming section of the east-central part of the State.



Fig. 20.—Dairy farms, number and geographical distribution in 1928.

DAIRY FARMS

Dairy farming in New Mexico is an unimportant industry. Of the total number of farms in the State in 1928, only 2.2 percent, or 839, were classified as dairy farms. While dairy farms are very scarce in most of the counties (figure 20), there is some concentration of farms of this type in the vicinity of the larger cities and towns, for example, in the vicinity of Albuquerque, Las Vegas, Clovis, Roswell, and in the Mesilla Valley north of El Paso, Texas. Roswell County, in the east central part of the State, contains approximately one-fifth of all the dairy farms.



Fig. 29.—Self-sufficing farms: number and geographical distribution in 1929.

SELF-SUFFICIENT FARMS

The self-sufficing farms in New Mexico in 1929 numbered 3,749 and made up approximately 15 percent of the total number of all farms and ranches combined. Numerically, this type ranked third that year. Figure 29 shows a marked concentration of the self-sufficing farms in the north-central part of the State and in the Middle Rio Grande Valley, where the Spanish-speaking population strongly predominates. The 3,749 self-sufficing farms in 1929 averaged 341 acres in size, harvested an average of 9.2 acres of crops, and had gross incomes averaging \$264 per farm. It is not known whether the families on these farms subsisted on the meager farm receipts or whether there were some incomes from other sources not covered by the census schedule.



Fig. 8.—Part-time farms, number and geographical distribution in 1929.

PART-TIME FARMS

Of the total number of farms in New Mexico in 1929, approximately 11 percent, or 3,212, were part-time. The distribution of these farms over the State is very similar to that of the self-sufficing farms (figures 29 and 30). There is a marked concentration of these farms in the Middle Valley of the Rio Grande and in north central New Mexico. It may be said, also, that part-time farms are to be found in almost all localities where farms of other types are located. The average size of the part-time farms in 1929 was 136 acres and the area of harvested crops averaged about 3.7 acres. Work away from the farms was the chief source of income of the operators of this type of farm.



FIG. 2.—Tree-planting and stocking areas, New Mexico (irrigated land in black).

TYPE-OF-FARMING-AND-RANCHING AREAS

In this study New Mexico has been differentiated into 25 type-of-farming and ranching areas and 33 subareas. Figure 31 shows the location and boundaries of each of these areas and subareas and table 8 gives their names and chief characteristics.

The preceding pages (Part I of this report) have dealt mainly with the historical background and geographical distribution of the agriculture of New Mexico; with the factors which have been and are now influential in making, shaping, and developing types of farming and ranching; and also with the major agricultural and industrial problems of the State. In delineating the State into type-of-farming areas and subareas, a wide range of information was used. The distribution of the crops, livestock, and types of farms over New Mexico is largely the result (1) of such physical factors as topography, altitude, type of soil, rainfall, and natural vegetation, and (2) of such economic factors as distance to market, available transportation facilities, and the relative profitability of the enterprises adapted to the State. All these factors, as well as recent farm and ranch practices, were given due consideration in locating the boundary lines of the type-of-farming areas and subareas. Part II of this report, which is to be published as a separate bulletin, describes in considerable detail each of the 25 type-of-farming areas and the 33 sub-