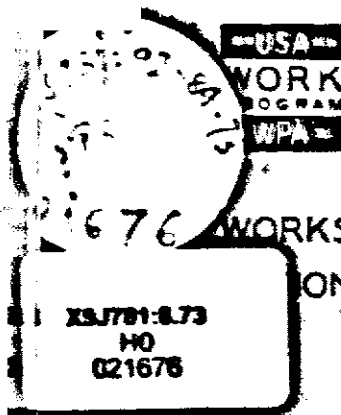


CHANGES IN TECHNOLOGY AND LABOR
REQUIREMENTS IN CROP PRODUCTION

COTTON



21676 WORKS PROGRESS ADMINISTRATION
ONAL RESEARCH PROJECT

THE WPA NATIONAL RESEARCH PROJECT
ON REEMPLOYMENT OPPORTUNITIES AND RECENT CHANGES
IN INDUSTRIAL TECHNIQUES

Under the authority granted by the President in the Executive Order which created the Works Progress Administration, Administrator *Harry L. Hopkins* authorized the establishment of a research program for the purpose of collecting and analyzing data bearing on problems of employment, unemployment, and relief. Accordingly, the National Research Program was established in October 1935 under the supervision of *Corrington Gill*, Assistant Administrator of the WPA, who appointed the directors of the individual studies or projects.

The Project on Reemployment Opportunities and Recent Changes in Industrial Techniques was organized in December 1935 to inquire, with the cooperation of industry, labor, and governmental and private agencies, into the extent of recent changes in industrial techniques and to evaluate the effects of these changes on the volume of employment and unemployment. *David Weintraub* and *Irving Kaplan*, members of the research staff of the Division of Research, Statistics, and Finance, were appointed, respectively, Director and Associate Director of the Project. The task set for them was to assemble and organize the existing data which bear on the problem and to augment the existing surveys and analyses.

Governmental agencies which are the sources of pertinent information were in co-operating agencies of the United States Department of Agriculture, the Department of the Interior, the Bureau of Labor, the Railroad Retirement Board, the Bureau of Economic Warfare, the Department of the Treasury, the Department of Commerce, the Federal Trade Commission, and the

Project was joined with the National Bureau of Economic Research, the Industrial Research Institute of the University of Pennsylvania, the Industrial Research Institute, Inc., the Employment Research Institute of the University of California, the Economics Departments in the University of California, Illinois,

WORKS PROGRESS ADMINISTRATION

HARRY L. HOPKINS
Administrator

CORRINGTON GILL
Assistant Administrator

NATIONAL RESEARCH PROJECT

on

Reemployment Opportunities and Recent Changes in Industrial Techniques

DAVID WEINTRAUB
Director

IRVING KAPLAN
Associate Director

Studies of Changing Techniques and Employment in Agriculture
John A. Hopkins, Economist in Charge



Bureau of Agricultural Economics, U.S.D.A.

FIELD OF COTTON NEAR PANTHER BURN, MISSISSIPPI

Dhananjayrao Gadgil Library



GIPE-PUNE-021676

**CHANGES IN TECHNOLOGY AND LABOR REQUIREMENTS
IN CROP PRODUCTION**

C O T T O N

by

William C. Holley

and

Lloyd E. Arnold

WORKS PROGRESS ADMINISTRATION, NATIONAL RESEARCH PROJECT

Report No. A-7

Philadelphia, Pennsylvania

September 1938

WORKS PROGRESS ADMINISTRATION

WALKER-JOHNSON BUILDING
1734 NEW YORK AVENUE NW,
WASHINGTON, D. C.

HARRY L. HOPKINS
ADMINISTRATOR

September 14, 1938

Hon. Harry L. Hopkins
Works Progress Administrator

Sir:

I am happy to be able to transmit to you a report on recent changes in the technology and labor requirements of cotton production. This report, in conjunction with materials contained in such other reports as *Landlord and Tenant on the Cotton Plantation* and *Part-time Farming in the Southeast* prepared by the Division of Social Research and the reports on the *Mechanical Cotton Picker* and on *Corn* prepared by the National Research Project, adds considerably to the information already available on economic conditions in the South.

Cotton is the largest cash crop produced in the United States and it is grown in one of the most highly specialized farm regions of the world. Its production involves some two million farms and about nine million persons. Since 1909 the infestation of the boll weevil has caused some profound changes in methods of production, in yields per acre and quality of staple, and in location of acreage and production. Problems of soil-fertility maintenance, particularly in the Eastern Cotton Area where much of the soil is severely eroded, have been aggravated by a system of land tenure which makes it difficult to follow any long-range program of soil conservation. In addition, with increased production in foreign countries, competition on the world market has become increasingly severe.

In the face of these difficulties technology has played an important role. Improved practices in growing cotton and the selection of early maturing varieties have not only checked the downward trend in yields that

followed the boll-weevil infestation, but also have resulted in regaining the levels which prevailed before the advent of the weevil. Since 1928 there has been a tendency toward increase in the average staple length of cotton. The establishment of one-variety communities and cotton demonstrations and the registration of improved varieties have aided in this development.

The average amount of labor required to produce a bale of cotton in the major cotton-producing areas for the period 1933-36 amounted to 253 man-hours in the Eastern Cotton Area, 250 in the Delta Area, and 178 in the Western Cotton Area. This amounts to 1.98 pounds of cotton per man-hour in the Eastern Area, 2.00 in the Delta Area, and 2.81 in the Western Area. Average prices of lint cotton in the United States were 10.2 cents in 1933, 12.4 cents in 1934, and 11.1 cents in 1935. These prices applied to the hourly productivity present a rough picture of gross hourly returns to the farmer; out of this hourly return of from 20 to 30 cents the farmer has to pay for fertilizer, equipment, feed for work stock, land rental, and all other expenses of production. Under these conditions incomes of the producers are anything but adequate. In the study, *Landlord and Tenant on the Cotton Plantation*, made by T. J. Woofter, Jr. of our Division of Social Research, average annual earnings in 1934 for the various classes of tenants covered by the survey were found to be \$180 per family for wage hands, \$312 for cropper families, \$417 for other tenant families, and \$354 for cash-rent families. When we consider the fact that tenancy in one form or another embraces a majority of the cotton producers, it is small wonder that the conditions under which cotton is produced have occupied a prominent place in the deliberations of governmental as well as private relief agencies.

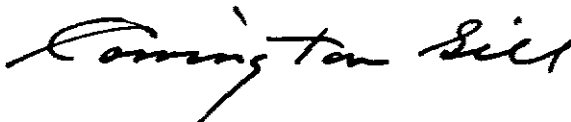
Throughout most of the Cotton Belt the family-size farm predominates as the unit of farm organization. Even on the large plantations landlords have shown preference for families to meet their labor needs. This organization of cotton production around the family resulted in a system of land tenure which has been both varied and insecure, particularly during the period covered by this study. In 1935 about 60 percent of the farms in the major cotton-producing areas were operated by tenants, about 40 percent of whom were croppers. The cropper differs very little from a hired laborer except that he assumes a large share of the risks of production. Various estimates place the average number

of years that a tenant occupies a farm at from 2 to 5 years. Farm tenancy and the mobility of tenants have had an important contributing effect on soil fertility and erosion and have made it difficult to plan any long-range soil-conservation program, for the tenant has little incentive to conserve or improve the soil.

In several of the important cotton-growing regions, notably in the Mississippi Delta and in western Areas, the trend toward mechanization has been greatly accelerated in the past few years. Numerous tenants have already been "tractored off" the land and now find employment on the cotton crop only as hired day laborers and for peak operations such as chopping and picking. There is evidence that this shift to tractor power and to larger implements requiring less farm labor per bale will continue. Furthermore, successful development of the experimental cotton-picking and cotton-chopping machines would greatly reduce the present seasonal peaks of employment.

This report on *Changes in Technology and Labor Requirements in Crop Production: Cotton* is one of a series of "Studies of Changing Techniques and Employment in Agriculture" conducted by our National Research Project on Reemployment Opportunities and Recent Changes in Industrial Techniques. The report was prepared by William C. Holley and Lloyd E. Arnold, under the direction of John A. Hopkins.

Respectfully yours,

A handwritten signature in cursive script that reads "Corrington Gill". The signature is written in black ink and is positioned above the typed name.

Corrington Gill
Assistant Administrator

CONTENTS

Section	Page
PREFACE	xv
I. INTRODUCTION	1
Trends in acreage.	6
Shifts in acreage as between areas	7
Trends in production and yield	8
The cotton farm.	10
Trends in tenure groups.	13
Purpose of study	15
Sources of data.	18
II. RECENT CHANGES IN OPERATIONS AND IN AMOUNTS OF LABOR USED IN COTTON PRODUCTION	19
The process of cotton production	19
Seedbed preparation.	22
Preparing the field: cutting sprouts and cleaning ditches and terraces	22
Cutting stalks	24
Flatbreaking or plowing.	26
Disking.	27
Harrowing.	29
Bedding and rebedding.	30
Laying off rows.	32
Distributing fertilizer.	33
Commercial fertilizer.	33
Side dressing.	35
Applying manure.	36
Planting	36
Discoveries regarding the spacing of cotton plants.	36
Practice in planting on farms surveyed	37
Labor requirements in planting	39
Cultivation.	39
Discoveries regarding the need for cultivation	39
Farm practice in cultivation	40
Labor requirements in cultivation.	42
Hoing and chopping.	44
Dusting and spraying	45
Harvesting	48
Method and times over.	48
Labor used per acre in harvesting cotton	52
Summary.	53

Section	Page
III. MECHANIZATION IN THE PRODUCTION OF COTTON.	55
Prospects for and limitations to mechanization.	55
Increased use of tractors.	58
Mechanical cotton picker	61
IV. PRINCIPAL INFLUENCES ON COTTON YIELD AND STAPLE LENGTH.	64
Improvement of cotton varieties.	64
Early improved varieties	65
Standard and improved varieties.	66
Varieties reported by growers in the NRP Farm Survey.	69
Cotton yield contests and demonstrations	69
One-variety communities.	71
Maintaining seed stocks in one-variety communities	74
Improvement achieved in upland cotton.	75
Tenderability of upland cotton	76
Recent developments in cultural practices.	78
Crop rotation.	78
Fertilizer	81
Fertilizer placement	86
Cotton diseases.	86
Root rot	87
Fusarium wilt.	88
Verticillium wilt.	88
Root knot.	89
Bacterial blight or angular leaf spot.	89
Anthracnose.	89
Treating cottonseed for planting	90
Insect enemies of the cotton plant	92
Cotton boll weevil	92
History.	92
Control measures	94
The cotton leaf worm and the bollworm.	95
V. SUMMARY AND CONCLUSIONS.	96
Changes in labor used in growing cotton on farms surveyed.	98
Eastern sections	98
Western sections	98
Changes in total labor used in cotton production	101
Estimated labor per acre and per bale.	102

CONTENTS

Section	Page
Shifts in cotton acreage between areas	108
Total labor used on cotton	107
Prospects for employment in the production of cotton.	108
 Appendix	
A. ACREAGE, YIELD, AND PRODUCTION OF COTTON IN THE UNITED STATES, 1909-36.	114
B. CULTURAL PRACTICES FOLLOWED ON FARMS SURVEYED, 1909-36	118
C. HOURS OF LABOR USED PER ACRE ON FARMS SURVEYED, 1909-36	118
D. VARIETIES OF COTTON, STAPLE LENGTH, AND APPLICATION OF FERTILIZER	120
E. TOTAL LABOR USED IN PRODUCING COTTON IN THE UNITED STATES.	124
F. ABSTRACT OF DATA FROM SECONDARY SOURCES, LABOR ON COTTON	128

CHARTS AND ILLUSTRATIONS

Figure	
Field of cotton near-Panther Burn, Mississippi.	<i>Frontispiece</i>
1. Major cotton-producing areas	2
2. Cotton acreage in major areas of the United States, 1909-36.	4
3. Location of changes in cotton acreage from 1909 to 1929.	5
4. Recently cleared land.	6
5. Cotton production in major cotton-growing countries, 1909-36.	8
6. Cotton yield per acre in major areas of the United States, 1909-36.	9
7. Cotton production in major areas of the United States, 1909-36.	11
8. Field of cotton ready for second picking	12
9. Bedding up with 1-horse turning plow	32
10. Laying off rows, fertilizing, and bedding.	35
11. Preparing land and planting cotton in South Carolina	39
12. Stock equipped with sweeps used for cultivating cotton in Darlington County, South Carolina.	41

CHARTS AND ILLUSTRATIONS-Continued

Figure	Page
13. Cultivating cotton with 2-horse, 1-row cultivator in the Mississippi Delta Section.	42
14. Chopping cotton.	45
15. Picking cotton by hand in North Carolina	48
16. A 2-row cotton picker.	49
17. Home-made sled used in harvesting cotton in the Western Semiarid Section	53
18. Cotton patch in the Eastern Cotton Area.	56
19. Bedding up four rows at a time	57
20. One-row middlebuster drawn by a light tractor.	57
21. Planting cotton and putting down fertilizer in one operation.	60
22. Four-row tractor cultivator.	60
23. Percentage distribution by staple length of cotton produced in the United States and in major areas, 1928-36.	77
24. Total fertilizer consumption in the major cotton-producing areas and average price of cotton in the preceding year, 1909-36.	83
25. Estimated reduction in yield of cotton caused by specified diseases	87
26. Spread of the cotton boll weevil, 1892-1932.	92
27. Estimated reduction in yield caused by the boll weevil, 1909-36.	93
28. Labor used per acre in producing cotton on farms surveyed, 1909-36.	97
29. Labor used per acre and per bale in producing cotton in major areas, 1907-11 to 1933-36	104

TEXT TABLES

Table	
1. Acreage, production, and farm value of major crops in the United States	2
2. Acreages of cotton planted in the United States by area, 1907-36.	7
3. Percentage distribution of all farm operators in the major cotton-producing areas by tenure, 1935	13
4. Number and percentage distribution of farm operators in the southern States, by tenure, 1910-35	14
5. Farms surveyed in cotton areas, number, acreage, and natural characteristics in 1936.	17

CONTENTS

xiii

TEXT TABLES-Continued

Table	Page
6. Preparing the field: cutting sprouts and cleaning ditches and terraces, percentage of farmers reporting the practice and hours of labor required per acre, 1909-36.	23
7. Cutting stalks by hand and with machine, percentage of farmers reporting the practice and hours of labor required per acre, 1909-36	25
8. Flatbreaking or plowing, percentage of farmers reporting the practice and hours of labor required per acre, 1909-36.	26
9. Disking, percentage of farmers reporting the practice and hours of labor required per acre, 1909-36. . .	28
10. Harrowing, percentage of farmers reporting the practice and hours of labor required per acre, 1909-36	29
11. Bedding and rebedding, percentage of farmers reporting the practice and hours of labor required per acre, 1909-36.	31
12. Laying off rows, percentage of farmers reporting the practice and hours of labor required per acre, 1909-36.	33
13. Applying commercial fertilizer, percentage of farmers reporting the practice and hours of labor required per acre, 1909-36.	34
14. Planting, percentage of farmers reporting, by size of planters, and hours of labor required per acre, 1909-36.	38
15. Cultivating, percentage of farmers reporting, by size of cultivator, frequency of cultivation, and hours of labor required per acre, 1909-36.	43
16. Hoeing and chopping, number of times over and hours of labor required per acre, 1909-36.	46
17. Dusting and spraying, percentage of farmers reporting the practice and hours of labor required per acre, 1909-36.	47
18. Labor required in harvesting, 1909-36.	50
19. Percentage of Oklahoma cotton acreage devoted to predominant varieties, 1928-31 and 1934.	68
20. Estimated percentage of Louisiana cotton acreage devoted to selected varieties in 1928 and 1934 . .	68
21. Staple length of South Carolina cotton, percentage of crop $\frac{1}{4}$ inch or longer as produced by contestants and the State at large and the average staple lengths of contest winners, 1928-36	70

TEXT TABLES-Continued

Table	Page
22. Cotton production of one-variety communities in Georgia, 1933-36	73
23. Average staple length of upland cotton produced in specified regions of Georgia and in the entire State, 1928-36	73
24. Effect on seed-cotton yield of turning under green manure cover crop with and without an application of nitrogen.	80
25. Percentage of cotton acreage fertilized and amount of fertilizer used per acre, by States, 1936	82
26. Percentage of cotton acreage fertilized and side dressed on farms surveyed in the Eastern Cotton Area, 1909-36.	84
27. Percentage distribution of farmers reporting the application of nitrogen, phosphorus, and potash, by amounts per acre, Eastern Cotton Area, 1909-36	85
28. Labor requirements for cotton production on farms surveyed, 1909-36.	99
29. Estimated labor requirements for cotton production in major cotton areas, 1909-36	103
APPENDIX TABLES	
A-1. Cotton, acreage harvested, 1909-36	114
A-2. Cotton, yield per acre, 1909-36.	115
A-3. Cotton, lint production, 1909-36	116
A-4. Number of farms surveyed and acreage per farm in all crops and in cotton, by counties, 1909-36.	117
D-1. Percentage distribution of farms reporting recognized varieties by principal variety reported in the three major cotton areas, 1909-36.	120
D-2. Average staple length of American upland cotton in the United States and in the three major cotton areas, 1928-36	122
D-3. Tenderability of American upland cotton ginned in the United States and in the three major cotton areas, 1928-36	122
D-4. Tons of fertilizer consumed in the three major cotton areas and price of cotton, 1909-35	123
E-1. Labor used in producing cotton in the United States, yearly averages for 1907-11 to 1933-36, by States	124
F-1. Abstract of data from secondary sources, labor on cotton.	128

PREFACE

Of the country's five major crops, cotton requires much the greatest amount of labor, both in total and per acre. This crop also, more than most others, has resisted the tendency toward mechanization in agriculture, although recently there have been indications of an introduction of power farming in some of the major cotton-producing areas.

Between the periods 1907-11 and 1933-36 the labor requirements of cotton production declined by 16 percent per acre or, on a per-bale basis, by 20 percent. The greatest declines took place in the Western Cotton Area, that is, the area which also experienced the greatest increase in production during the period. The marked shift in the geographic distribution of cotton production to Oklahoma, Texas, and the far West has resulted in some economy in the utilization of labor. This shift is, however, partly offset by the increased proportions produced in the Delta Area, where labor requirements are above the average and where production has been more quickly adjusted to the changed requirements imposed by the boll weevil.

The decline in labor requirements per acre and per bale, in which all areas shared to some extent, reflects the increasing application of more efficient equipment. The development and introduction of large-scale and expensive equipment in cotton production has been seriously impeded by the small size of the farm unit and by the prevailing system of land tenure, particularly in the Old South. However, the accumulation of possibilities for economies through the use of modern equipment may overcome the resistance against extensive mechanization. These factors may in turn tend to change the tenancy and sharecropping system under which cotton is now raised in the Old South.

The tractor is now available for the preharvest operations of seedbed preparation, planting, and cultivation. Its use is feasible wherever the topography of the country presents level or gently rolling land, as in the Mississippi Delta, the Western Cotton Area of Oklahoma and northwest Texas, and the cotton lands of California, Arizona, and New Mexico. Under such conditions the use of the tractor is economical when cotton is grown on large farm units, such as exist in relatively greater numbers in the areas west of the Mississippi where the topography is

most favorable. In all these areas tractors have been gradually replacing horsepower. Increasing sales of tractors and displacement of sharecroppers, with attendant increased demand for seasonal laborers, were reported in 1937. In the Mississippi Delta, for instance, sharecroppers and share tenants have already been displaced to some extent by wage labor, whereas in the western Areas a large proportion of the cotton has for some time been harvested by migratory labor.

A primary obstacle to the extended mechanization of preharvest operations is the peak labor requirements for harvesting operations. The development of the mechanical cotton picker raises prospects for overcoming this impediment. It is believed that machines now under development warrant expectations of their adoption during the next decade. They are especially adaptable to use on the relatively level lands favorable to the use of tractors, and they are likely to be used there first. A further shift in cotton production to such lands may then be expected, accompanied by an increase in the size of cotton farms. The successful development of a mechanical cotton chopper, such as was recently reported, would enhance the prospects for adoption of a successful cotton picker by reducing the secondary peak of labor requirements in cotton production.

Valuable assistance in compiling material for this report was had from various bureaus of the United States Department of Agriculture and from several State experiment stations. The interpretations of material used are of course the responsibility of the National Research Project alone.

DAVID WEINTRAUB
IRVING KAPLAN

PHILADELPHIA

July 30, 1938

SECTION I

INTRODUCTION¹

Cotton is not only the major crop south of the thirty-seventh parallel; it is also the most important cash crop produced in the United States. Corn, although exceeding cotton in total value, is largely consumed on the farms where it is grown, whereas all the lint from cotton and most of the seed are sold off the farm.

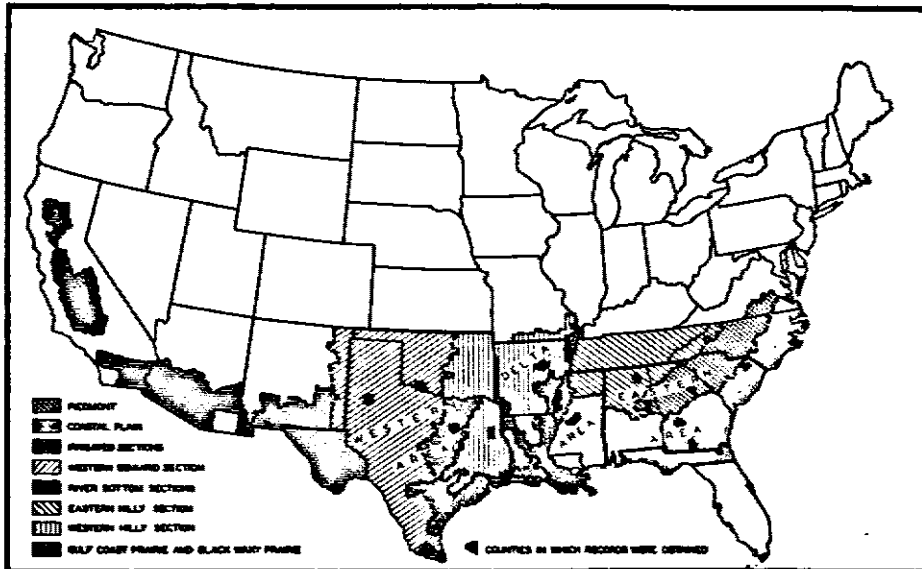
During the last 25 years there has been a change in the relative importance of the United States as a cotton producer. In the period 1908-10 the United States produced 11.6 million bales, or 62 percent of the world's supply of cotton, compared with 11.1 million bales, or 44 percent, in the period 1933-35. The latter period, however, was one of unusually low production because of drought and the Agricultural Adjustment Administration's crop-control program. Since approximately 50 percent of the cotton crop is marketed abroad, the prosperity of the South depends to a large extent upon world supply and demand for cotton. Of the 50 countries producing cotton at the present time, the most important, other than the United States, are India, Egypt, China, Brazil, and Russia.

Foreign cotton acreage increased from 30 million acres in 1921 to a record high of 45 million acres in 1933-35. Reports indicate that there are possibilities of substantial expansion of cotton acreage in India, Africa, Brazil, and Argentina. The extent to which such expansion occurs will depend not alone upon prices but also upon governmental policies, availability of land suited to cotton and of labor capable of growing it, and advantages of competing or alternative crops.

The relative importance of the cotton crop in the agriculture of the United States may be inferred from the data in table 1. During the period 1924-29 cotton stood fourth among crops in acreage occupied, being exceeded only by corn, wheat, and hay. In value, however, cotton was even more important than its acreage indicates and was second only to corn, having a total farm value of over 1½ billion dollars.

¹This section was prepared by William C. Holley.

Figure 1.- MAJOR COTTON-PRODUCING AREAS



*PA - National Research Project

A-65

Table 1.- ACREAGE, PRODUCTION, AND FARM VALUE OF MAJOR CROPS
IN THE UNITED STATES^a

(1924-29 averages)

Crop	Acres harvested (thousands)	Production ^b	Price per unit ^c (dollars)	Total farm value (millions of dollars)
All crops	357,666 ^d	-	-	9,879 ^e
Cotton and cottonseed	42,084	14,995	0.183 ^f	1,558
Corn	99,617	2,562	0.832	2,115
Hay ^g	70,326	86	12.950 ^h	1,277
Wheat	57,285	826	1.188	972
Oats	41,264	1,249	0.427	533

^aData derived from *Agricultural Statistics, 1937* (U. S. Dept. Agr., 1937), but data on cottonseed for 1924 and 1925 were obtained from *Yearbook of Agriculture, 1927* (U. S. Dept. Agr., 1928).

^bCotton in thousands of bales of lint, grain in millions of bushels, hay in millions of tons.

^cAverage seasonal price received by producers.

^dData for: 1924-26 from *Yearbook of Agriculture, 1926* (U. S. Dept. Agr., 1927), p. 1200; 1927-29 from same for 1930 (1930), p. 970.

^e*Farm Value, Gross Income, and Cash Income from Farm Production, 1924-1929, Part V, "General Summary of the Income Estimates"* (U. S. Dept. Agr., Bur. Agr. Econ., mimeo. report, 1930); same for 1929-30 (1931).

^fAverage price per pound of lint.

^gIncludes tame hay and wild hay.

^hAverage December 1 farm price of tame hay only.

The Cotton Belt is one of the most highly specialized farm regions of the world (figure 1). Bounded on the north by the "frost line", which marks the northern limit of a 200-day frost-free growing season and a mean summer temperature of not less than 77° F., the belt dips irregularly to the south around the higher altitudes of the southern Appalachian System, north again in the low, level lands of the Mississippi, and then bends to the southwest in response to both inadequate rainfall and low temperatures. On the east and south the Cotton Belt is fringed by a subtropical border, beginning in the Carolinas and following around the Gulf, which includes practically all of Florida and is characterized by swampy lowlands and excessive rainfall.

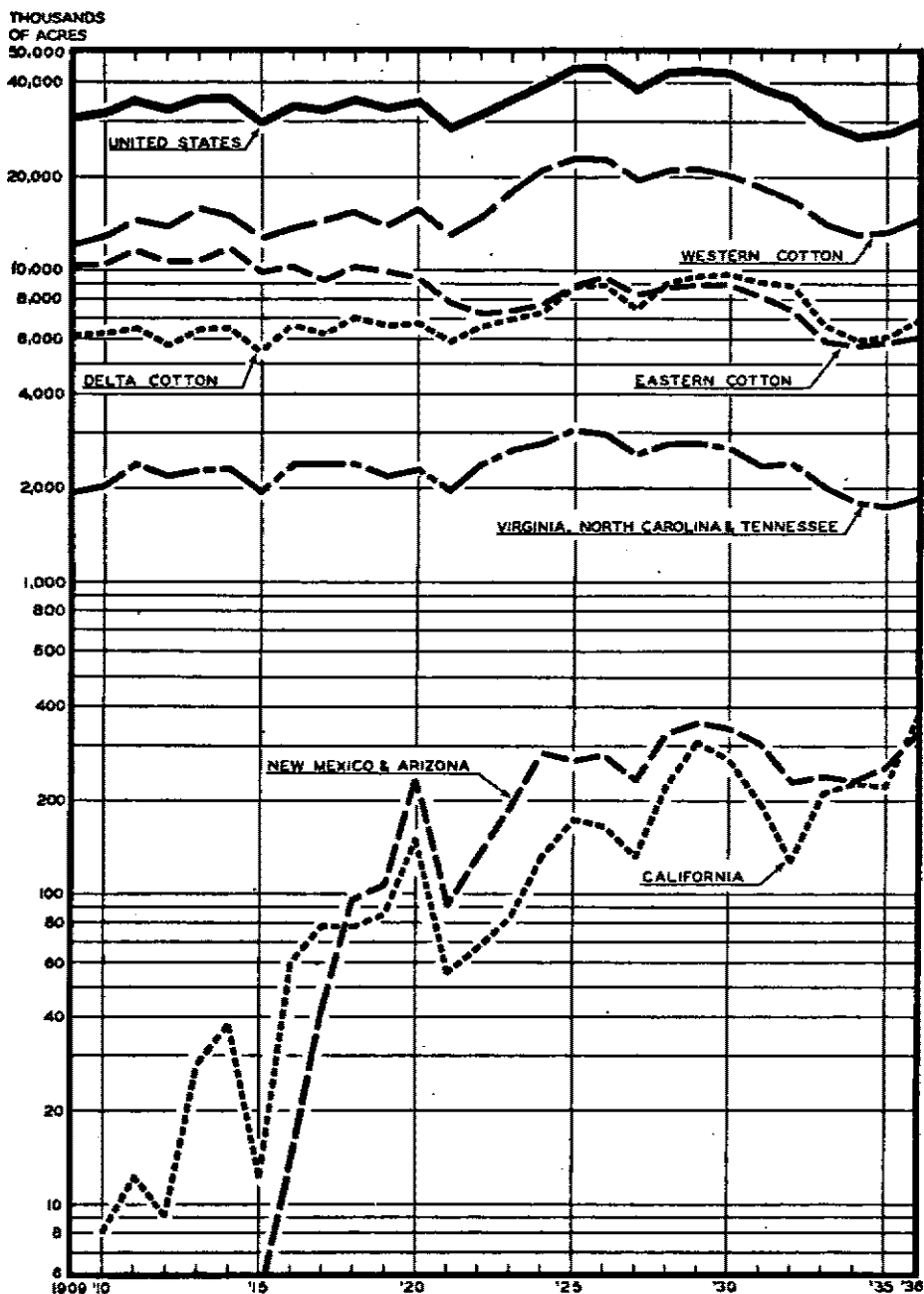
As is shown in figure 1, there are several fairly distinct sections of the Cotton Belt. The areas east of the Mississippi River are often referred to as the Old Cotton Belt and those to the west as the New Cotton Belt. Each of these, however, consists of several different sections. As we go from east to west we come first to the sandy and level Coastal Plain, which extends in a semicircle from southeastern Virginia to the Mississippi River and includes from a third to a half of each State from North Carolina to Mississippi. To the north and west of this lies the Piedmont and then the rougher Eastern Hilly Section. In both of these erosion is a serious problem and the cotton is ordinarily raised in small, irregular-shaped and terraced fields. In general these eastern sections have seen declines in cotton production since 1909 because of the eastward migration of the boll weevil. This decline appeared first in Mississippi and Alabama, and later in Georgia and South Carolina. These changes in acreage are shown in figure 2.

Proceeding westward, we find the broad delta or river-bottom areas along the Mississippi. Cotton has been produced here for many years. During the 1920's, however, additional land was drained and cleared. Consequently the cotton acreage in the three Delta States of Arkansas, Louisiana, and Mississippi increased from about 7 to 9 million acres between 1920 and 1930, although part of this increase was in sections other than the bottom lands.

West of the bottom lands we come to the Western Hilly Section, which includes the western part of Arkansas and Louisiana and parts of eastern Oklahoma and Texas. This section greatly resembles the Piedmont or Eastern Hilly Sections but was more recently developed and has seen increasing instead of declining cotton acreage since 1909.

Figure 2.- COTTON ACREAGE IN MAJOR AREAS
OF THE UNITED STATES, 1909-36

(Semi-logarithmic scale)

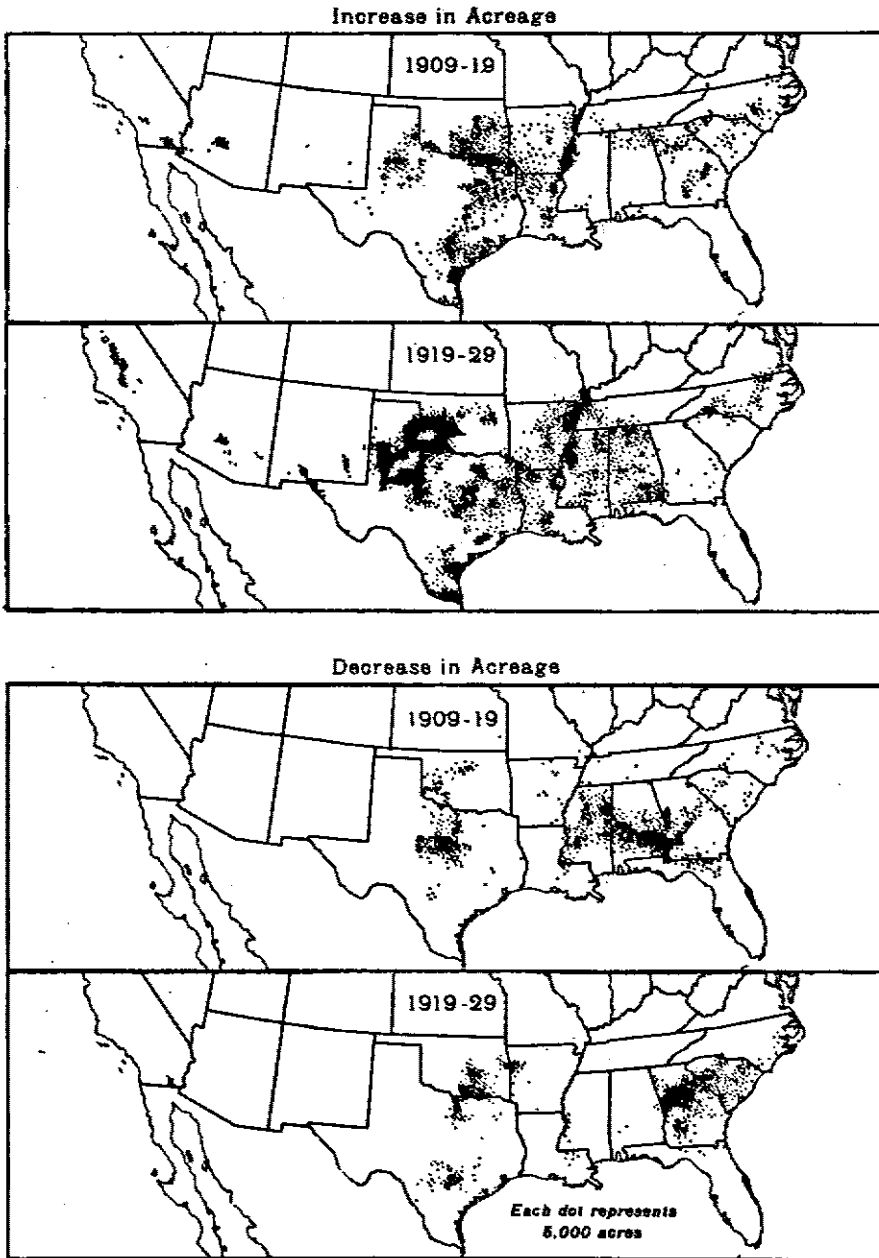


Based on table A-1

WPA - National Research Project

A-66

**Figure 3.- LOCATION OF CHANGES IN COTTON ACREAGE
FROM 1909 TO 1929**



Bureau of Agricultural Economics, U.S.D.A.

Next come the Black Waxy Prairie and the Texas Coastal Plain, which are adjoined by the semiarid section of the Low Plains and the High Plains. These also have seen increasing production since 1909, particularly the High Plains which, during the first decade of this century, were devoted largely to range.

TRENDS IN ACREAGE

As shown in figure 2, cotton acreage in the United States has been shifting from east to west in the Cotton Belt and into the irrigated areas of southern California and Arizona. The acreage harvested in the Western Cotton Area increased from 11.8 million acres in 1909 to a high of 22.6 million acres in 1925. The greatest relative increase in acreage harvested is found in California, where there was a rise from 8,000 acres in 1910 to 368,000 in 1936. In New Mexico and Arizona there was an increase from 41,000 acres harvested in 1917 to 353,000 in 1929. After 1929 there was a decrease in the acreage harvested in all areas as a result of low prices, the cotton-reduction program of the Agricultural Adjustment Administration, and drought.



WPA - National Research Project

FIGURE 4.- RECENTLY CLEARED LAND

Much land in the Mississippi Delta section has been drained and cleared since 1909. Here cotton is seen growing in a field with girdled and dead trees still standing.

SHIFTS IN ACREAGE AS BETWEEN AREAS

As shown in table 2, total cotton acreage increased from 1907 until 1931. However, the acreage in the Eastern Cotton Area (Alabama, Georgia, and South Carolina) was smaller in each period than in the one before. The percentage of the total crop that was raised in this area declined over one-third. In the Delta Area, made up of Arkansas, Louisiana, and Mississippi, the acreage increased about two-fifths between the beginning of the period and the years 1927-31.

The greatest absolute increase occurred in the Western Cotton Area, composed of Oklahoma and Texas, and amounted to nearly 8 million acres so that the percentage which the acreage in this area was of the total increased from 39 to 49. The greatest relative increase occurred in Arizona, California, and New Mexico,

Table 2.- ACREAGES OF COTTON PLANTED IN THE UNITED STATES BY AREA, 1907-36^a

Area	1907-11	1917-21	1927-31	1933-36
	Acres planted (thousands)			
United States	32,567	33,870	42,019	31,731
Eastern	10,984	9,629	8,869	6,423
Delta ^b	6,784	6,805	9,438	7,380
Western	12,707	14,966	20,506	15,387
Middle Eastern	2,078	2,245	2,644	1,978
Irrigated	4	208	542	536
All other States ^c	10	17	20	27
	Percent of acres planted			
United States	100.0	100.0	100.0	100.0
Eastern	33.7	28.4	21.1	20.2
Delta ^b	20.8	20.1	22.5	23.3
Western	39.0	44.2	48.8	48.5
Middle Eastern	6.4	6.6	6.3	6.2
Irrigated	*	0.6	1.3	1.7
All other States ^c	*	*	*	0.1

^a Acreages from *Cotton Revisions, Acreage, Yield and Production, Crop Years 1866-1935, by States* (U. S. Dept. Agr., Bur. Agr. Econ., Crop Reporting Board, mimeo. Nov. 1936); and *Crops and Markets*, 13, No. 12 (Dec. 1936), p. 422.

^b Including Missouri.

^c Illinois, Kansas, and Kentucky.

* Less than 0.05 percent.

where cotton is raised on irrigated land. In these three States an average of 4,000 acres was reported for the years 1907-11, as compared with 542,000 acres in 1927-31 and over a million acres in 1937. As will be shown later, these changes are highly important in their effects on the average hours per acre for the country as a whole and go far toward explaining the trends in the total amount of labor used on the crop.

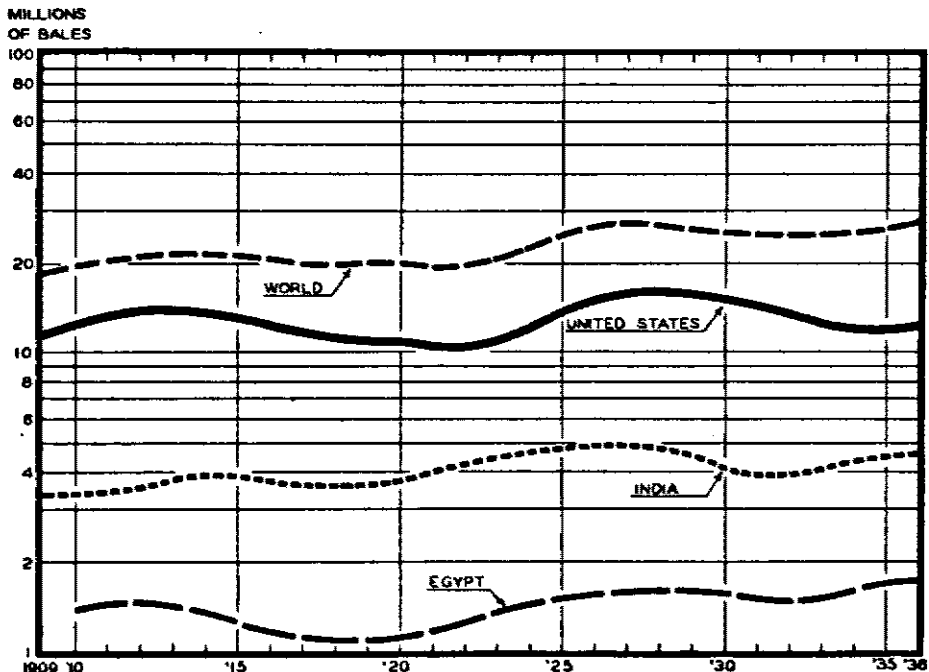
TRENDS IN PRODUCTION AND YIELD

World cotton production has fluctuated from year to year, and periods of rapid expansion have been followed by others of slow growth or declines, but during the period 1909-36 the trend has been upward, as shown in figure 5. Foreign production has risen more rapidly than production in the United States.

In the United States, production has fluctuated widely from year to year because of variations in yields. Figure 6 shows for the United States the average yield per acre. Major factors

Figure 5.- COTTON PRODUCTION IN MAJOR COTTON-GROWING COUNTRIES, 1909-36

(Semi-logarithmic scale)

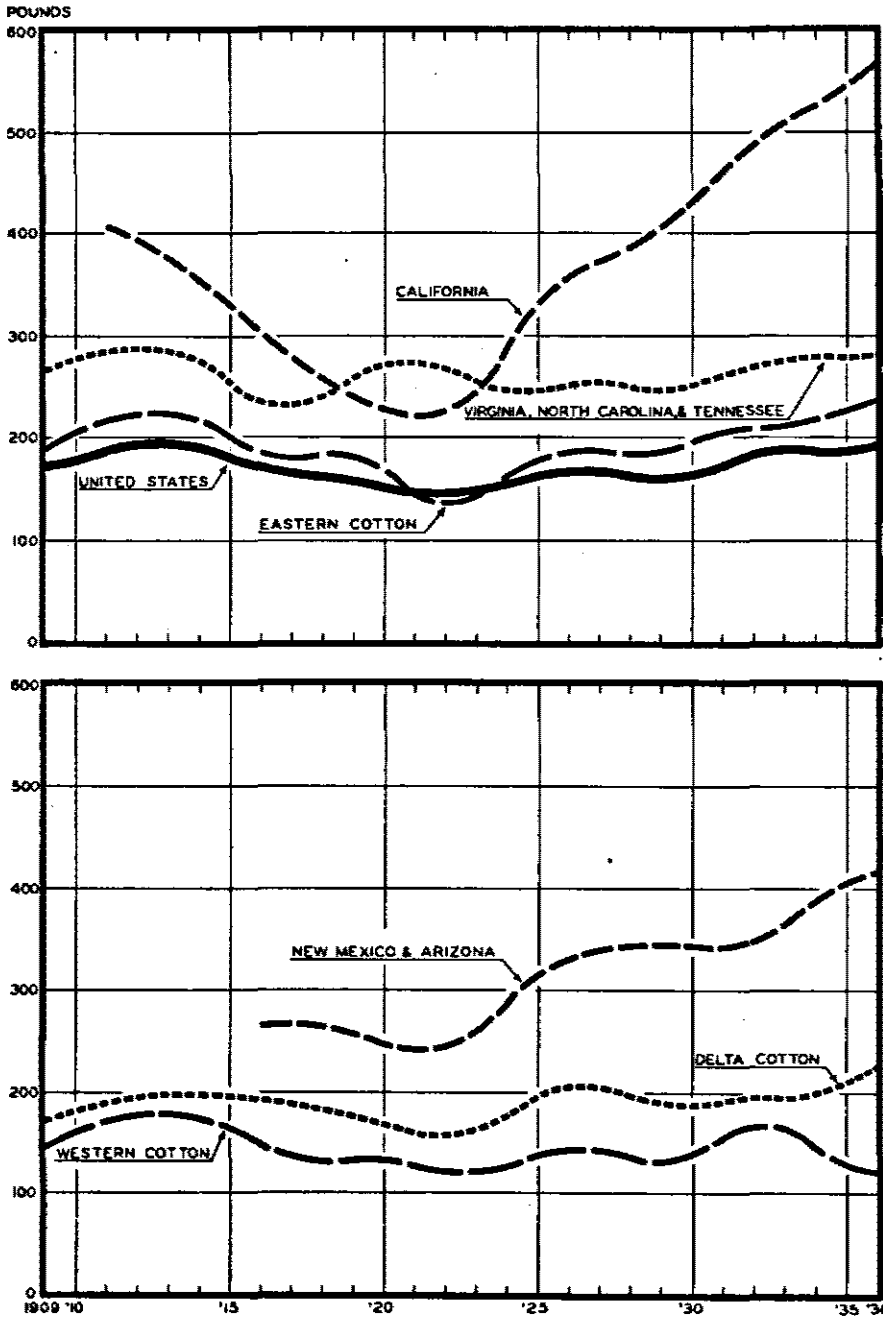


Freshhand curves based on data from *Agricultural Statistics, 1937* U. S. Dept. Agr., 1937, p. 92

NRA - National Research Project

A-67

Figure 6.- COTTON YIELD PER ACRE IN MAJOR AREAS OF THE UNITED STATES, 1909-36



Freehand curves based on table A-2

WPA - National Research Project

A-68

affecting changes in yields for the country as a whole are shifts in relative quantities produced in different areas, variations in climatic conditions, changes in the use of fertilizers, improved seed, developments in methods of production, and the varying degree of infestation by the boll weevil.

Between the periods 1907-10 and 1913-15 production increased by about 2.5 million bales. Following this period, production declined because of boll-weevil infestation and reached a record low in 1921. By 1926 a partial recovery in yields and a new high level of acreage resulted in nearly 18 million bales, the largest crop ever produced to that time. By 1934, production had declined to 9.6 million bales because of the factors previously mentioned. This, however, was followed by recovery to 12.4 million bales in 1936 and a record crop of 18.7 million bales in 1937.

The proportion of the cotton crop produced in the western areas has been increasing, as shown in figure 7. This has tended to keep cotton prices down, to the disadvantage, particularly, of the older cotton sections.

THE COTTON FARM

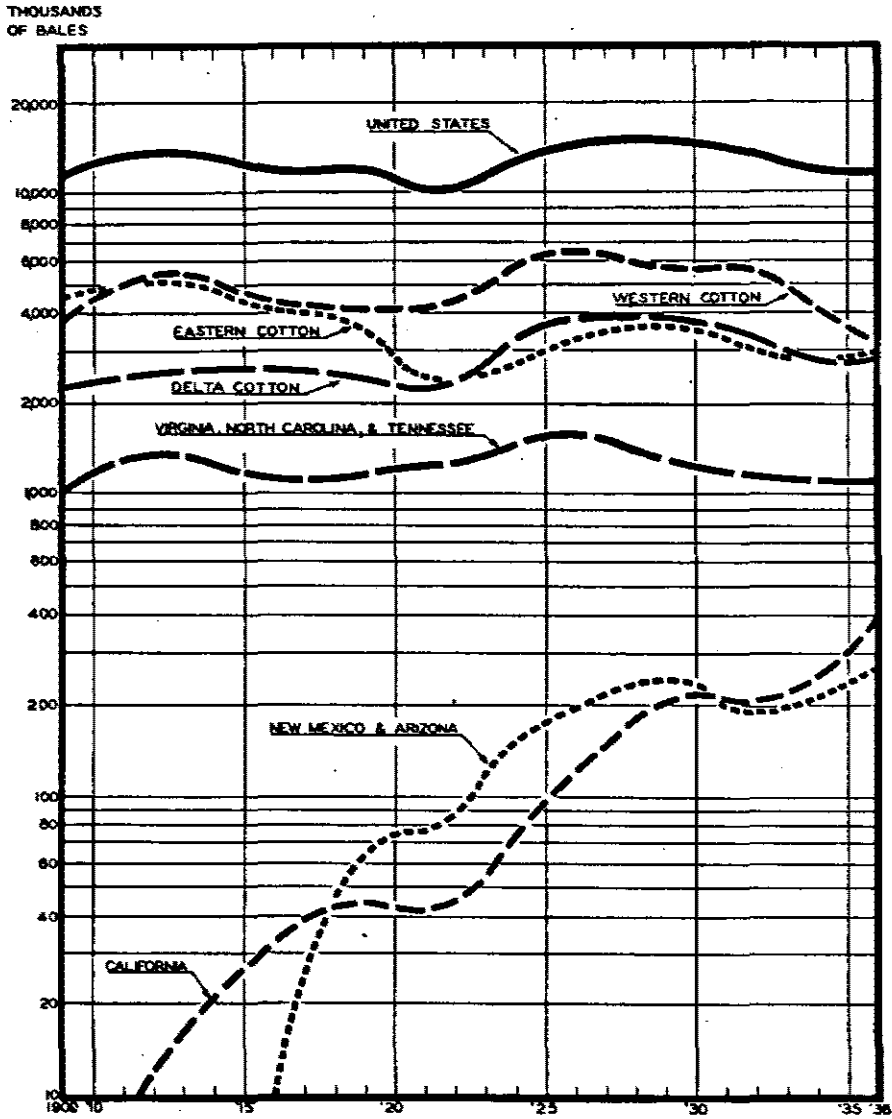
The census of 1929 reported just under 2 million farms producing cotton, and of this number about 80 percent, or 1,640,000, were classified as primarily cotton farms.² The average cotton farm consisted of 67 acres of land in the Eastern Cotton Area, 50 acres in the Delta Area, and 110 acres in the Western Cotton Area.³ Not all of this land, however, was available for crops, as slightly less than half in the Eastern and Delta Areas and about 60 percent in the Western Cotton Area represented harvested crops in 1929. Since there were about 43 million acres of cotton harvested in 1929, this means that the average acreage of that crop for all the farms reporting it amounted to just over 20 acres.

²*Fifteenth Census of the United States: 1930, "Agriculture"* (U. S. Dept. Com., Bur. Census, 1932), vol. II, part 2, United States table V, p. 18 and vol. III, part 2, State table III, p. 24.

³The Eastern Cotton Area consists of the States of Alabama, Georgia, and South Carolina. The Delta Area consists of Arkansas, Louisiana, and Mississippi, and the Western Cotton Area is made up of Oklahoma and Texas. The Middle Eastern Area consists of Virginia, North Carolina, and Tennessee.

Figure 7.- COTTON PRODUCTION IN MAJOR AREAS OF THE UNITED STATES, 1909-36

(Semi-logarithmic scale)



Freehand curves based on table A-3

EPA - National Research Project A-69

In the States east of the Mississippi River, however, the cotton acreage per farm averaged about 15 acres while in Texas it was over 40.

The typical cotton farm represents a relatively small investment as farms go. In 1930 this investment averaged about \$1,900 for land and buildings in the States of the Eastern and Delta Areas, while in the Western Cotton Area it averaged slightly over \$5,000. The value of equipment on cotton farms in the eastern areas averaged less than \$115 per farm, and on farms in the Western Cotton Area slightly under \$300.⁴



Bureau of Agricultural Economics, U.S.D.A.

FIGURE 8.— FIELD OF COTTON READY FOR SECOND PICKING
A typical farmstead is seen in the background.

At the same time the value of the cotton crop plus the other products which are raised on such farms is notoriously low. For the period 1924-29 the average gross income per farm for all farms in the Eastern and Delta Cotton States averaged just under \$1,000, as compared with \$1,680 for those in the Western Cotton Area. Of these amounts, between \$200 and \$250 per farm represented produce raised and consumed on the farm. That is, the gross cash income averaged slightly under \$800 per farm in the

⁴Fifteenth Census of the United States: 1930, "Agriculture" (U. S. Dept. Com., Bur. Census, 1932), vol. IV, chap. XIV, table 7 and vol. III, part 2, State table III.

two eastern areas and under \$1,500 in the Western Cotton Area. For the period 1930-35 the corresponding figures for average gross cash income were about half as great as in the late 1920's. Out of these sums the farmers must buy fertilizer and seed, repair equipment and replace it when it is worn out, and pay taxes, interest on indebtedness, wages of any hired labor, and the other expenses of operating their farms. It is safe to say that during the recent period many families in the Cotton Belt had less than \$100 per year to spend for themselves.⁵

Trends in Tenure Groups

The farms in the South are divided among owners, croppers, and other tenants, as shown in table 3.

Table 3.- PERCENTAGE DISTRIBUTION OF ALL FARM OPERATORS IN THE MAJOR COTTON-PRODUCING AREAS BY TENURE, 1935⁶

Tenure	Area			
	Middle Eastern	Eastern Cotton	Delta Cotton	Western Cotton
All operators	100	100	100	100
Full owners	52	30	31	32
Part owners	9	5	4	9
Managers	*	1	*	1
Croppers	14	28	34	12
Other tenants	25	36	31	46

⁶United States Census of Agriculture: 1935 (U. S. Dept. Com., Bur. Census, 1936), vol. 1, table III, supplemental for the Southern States.

*Less than 0.5 percent.

Sharecroppers number about one-third of all the farmers in the Eastern and Delta Areas and one-seventh in the Middle Eastern and the Western Cotton Areas. These operators have a status between that of a cropshare tenant and a hired laborer. Or they might be described as hired men who are paid a share of the crop instead of a fixed wage.

The trends in numbers of farmers in the southern States and the percentages in each tenure group are shown in table 4. The

⁵Figures on income are from: *Farm Value, Gross Income, and Cash Income from Farm Production, 1924-1929* (U. S. Dept. Agr., Bur. Agr. Econ., Wmsco., Oct. 1930); same for 1929-30 (Sept. 1931); *Income from Farm Production in the United States, 1933* (U. S. Dept. Agr., Bur. Agr. Econ., 1934); same for 1935 (Sept. 1936); *Crops and Markets*, Vol. 12, No. 7 (July 1936).

total number reported by the census for 1935 was about 10 percent greater than that for 1910. Almost the entire increase was in the tenant groups. The greatest relative change appears to have occurred in the sharecropper group which increased from 561,000 in 1920 to 776,000 in 1930. From 1930 to 1935 the census shows an apparent increase of nearly 200,000 farm operators, but a part of this appears to be attributable to more complete enumeration in 1935 than in 1930. Numbers of owners and of tenants other than croppers each increased about 10 percent, while croppers decreased 8 percent. In 1920, sharecroppers comprised 17.5 percent of the total farm operators in southern States. By 1930 they had increased to 24.1 percent, but in the next 5 years they had declined to 20.9 percent, as shown in table 4. First low-priced cotton then the cotton-control programs of the Agricultural Adjustment Administration made it unprofitable for plantation owners to continue to operate on as large a scale as before. Also the continued adoption of larger equipment in the Mississippi Delta and in the western areas permitted a reduction in the number of workers needed to grow the allotted acreage of cotton. It is

Table 4.- NUMBER AND PERCENTAGE DISTRIBUTION OF FARM OPERATORS IN THE SOUTHERN STATES, BY TENURE, 1910-35^a

Tenure	1910	1920	1925	1930	1935
	Number (thousands)				
Total - all operators	3,098	3,207	3,131	3,224	3,422
Owners ^b	1,545	1,597	1,519	1,416	1,575
Managers	16	18	11	17	16
Croppers	1,537	581	623	776	716
Other tenants		1,030	978	1,015	1,115
	Percent				
All operators	100.0	100.0	100.0	100.0	100.0
Owners ^b	49.9	49.8	48.5	43.9	46.0
Managers	0.5	0.6	0.4	0.5	0.5
Croppers	49.6	17.5	19.9	24.1	20.9
Other tenants		32.1	31.2	31.5	32.6

^aData for: 1910 from *Fourteenth Census of the United States: 1920, "Agriculture"* (U. S. Dept. Com., Bur. Census, 1922), vol. V, chap. VI, table 7, pp. 355 ff.; 1920 and 1925 from *Fifteenth Census of the United States: 1930, "Agriculture"* (U. S. Dept. Com., Bur. Census, 1932), vol. IV, chap. III, table 7, p. 156; 1930 and 1935 from *United States Census of Agriculture: 1935* (U. S. Dept. Com., Bur. Census, 1937), vol. III, chap. III, table 2, p. 106.

^bIncludes "part owners", who rent a part of the land operated.

to be expected that the croppers will continue to bear the brunt of mechanization, as well as of any further reduction in acreage. As was said previously, the sharecroppers are primarily laborers who are paid in the form of a share of the crop. As owners or tenants on larger farms adopt mechanical power and larger equipment, they will be able to plant and cultivate more acres themselves and will need fewer croppers. Many of the latter are likely to become seasonal laborers who will help with the chopping and picking, unless these operations also can be mechanized.

PURPOSE OF STUDY

The United States cotton crop is raised on about 2 million farms which have a total population of approximately 9 million persons. There has been considerable apprehension that current or impending changes in the methods of producing this crop may result in a serious displacement of agricultural employment in the Cotton Belt. This study was undertaken in order to throw what light may be possible on this question.

The study is limited to determining the trends in the amount of labor used in producing the cotton crop and to examining the technological changes which have affected the trends. This includes consideration of the cultural practices followed on cotton-producing farms and changes in the amount of labor required in performing them. The changes in the average amounts of labor used per acre or per bale may come either from improving, dropping, or combining certain practices, or from the adoption of larger farm machines, or as a result of shifts in the relative acreages of cotton raised in the different areas, which vary widely in practices used and the labor required per acre and per bale. Still another group of factors which affect the labor required to produce the cotton crop is that which comprises the influences on yield. They include the development of new varieties of cotton, the crop rotations followed, the application of fertilizers, and the methods used in combating cotton diseases and insect pests.

The report does not attempt to cover the general economics of cotton production with regard to competition between cotton and other crops, the world supply of and the world demand for cotton, or the development of products competing with cotton. It does not deal with the general influences affecting the relative profitability of this crop as compared with other farm products or

with other lines of employment available to people now engaged in cotton production. Its purpose is to throw whatever light may be possible on the effects of technological changes, as described in the preceding paragraph, on the amount of labor used in cotton production in the United States.

More specifically, the purposes of the study are: (1) to trace the major technological developments affecting cotton production, (2) to describe the practices and methods used in the several cotton-producing areas and to determine the rate and extent of changes in these practices since 1909, (3) to estimate the amount of labor used in producing cotton in selected areas and in the United States at specified periods since 1909, and (4), in the light of the findings under these three points, to estimate the labor requirements of this crop in the immediate future.

SOURCES OF DATA

Basic information on changes in cultural practices and amounts of labor used in cotton production was obtained from available publications of the United States Department of Agriculture and State experiment stations. This information was supplemented by a field study in 1936 of 14 counties in the Cotton Belt. The counties selected are believed to be representative of the surrounding larger areas. They include as many localities as possible where similar studies had been made in the past by other agencies, thus providing a check on the 1936 survey data covering earlier years, i. e., data based on the memory of the farmers. The areas covered by the 1936 survey are shown in figure 1. Their location insures the representation of most of the conditions and practices found in the Cotton Belt. Data were obtained on the acreages of the various crops and the number of livestock on each farm, as well as on the total amount of labor employed, together with a detailed statement of the cultural practices and labor used in producing cotton. A total of 1,026 farm records was obtained.

In order to facilitate the analysis and the discussion of practices and of amounts of labor used in producing the crop, the Cotton Belt was divided into seven sections, as shown in figure 1. Schedules from the counties studied were grouped accordingly. The major topography, soil type, and number of schedules obtained in each county are shown in table 5, together with the total

Table 5.- OCCUPATIONAL GROUP OF USUAL OCCUPATION OF EMPLOYABLE PERSONS, BY EMPLOYMENT STATUS AND SEX

Occupational group	Total				Employed full time				Employed part time				Unemployed ^a			
	Men		Women		Men		Women		Men		Women		Men		Women	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total ^b	55,840	100.0	23,754	100.0	40,808	73.1	15,327	64.5	2,018	3.6	1,989	8.4	13,014	23.3	6,438	27.1
Skilled and semiskilled occupations in manufacturing and mechanical industries	22,528	100.0	7,374	100.0	16,804	74.6	5,157	69.9	831	4.1	561	7.6	4,791	21.3	1,656	22.5
Building and construction	4,986	100.0	0	-	3,238	65.2	0	-	292	5.9	0	-	1,436	28.9	0	-
Metal products, machinery, and electrical-goods manufacturing	5,239	100.0	308	100.0	4,220	80.5	155	50.7	94	1.8	9	2.9	925	17.7	142	46.4
Printing establishments	829	100.0	119	100.0	678	81.8	91	75.5	46	5.5	11	9.2	105	12.7	17	14.9
Textile and clothing manufacturing	3,964	100.0	4,536	100.0	2,821	71.1	3,156	69.6	284	7.2	420	9.2	859	21.7	660	21.2
Other	7,528	100.0	2,413	100.0	5,847	77.7	1,755	72.7	215	2.8	121	5.0	1,466	19.5	537	22.3
Unskilled labor	6,504	100.0	22	100.0	3,866	59.4	15	68.2	376	5.8	2	9.1	2,262	34.8	5	22.7
Clerical work	4,355	100.0	4,701	100.0	3,651	83.8	4,060	86.4	49	1.1	105	2.2	655	15.1	536	11.4
Transportation and trade pursuits	10,869	100.0	2,040	100.0	8,661	81.2	1,617	79.2	301	2.8	138	6.8	1,707	16.0	285	14.0
Domestic and personal service	4,233	100.0	6,130	100.0	3,126	73.9	3,508	57.2	183	3.9	905	14.8	944	22.3	1,717	28.0
Executive, professional, and semi-professional occupations	4,099	100.0	1,397	100.0	3,526	86.0	961	68.6	162	4.5	278	19.9	391	9.5	159	11.3
Public-service occupations	1,263	100.0	11	100.0	1,174	92.9	9	61.8	16	1.3	0	-	73	5.8	2	18.2
Not previously employed	2,191	100.0	2,079	100.0	-	-	-	-	-	-	-	-	2,191	100.0	2,079	100.0

^aIncludes persons employed on emergency Works Program projects.

^bExcludes 8 men and 4 women who did not report usual occupational group.

INCIDENCE OF UNEMPLOYMENT

and of the last job⁵ for persons unemployed at that time were recorded. Data were also obtained on the character of employment and length of service on the present or last job. Ninety-four percent of the men and 97 percent of the women reported that their present job in May 1937 or their last job was at their usual occupation; slightly more, that it was in the same occupational group as their usual occupation. High proportions of the workers (94 percent of the men and 97 percent of the women) also reported that their present or last job was in the same industrial group as their usual industry. The similarity between the occupation and industry of the most recent job and the usual occupation and industry may be due in part to the interpretation of the terms "usual occupation" and "usual industry" by household members furnishing information. Data pertaining to the last or present jobs are most easily recalled. There is also some inclination, particularly on the part of persons with little specialized training and those who have worked at a variety of jobs, to consider their most recent employment as their usual or customary work.

The proportion of unemployed men who had last worked at skilled and semiskilled occupations in manufacturing and mechanical industries was only slightly larger (43 percent) than the proportion of employed men (41 percent) who were working at these occupations in May 1937 (table C-10). The difference was greater in the case of men engaged in building and construction trades. Over 12 percent of the unemployed men had last worked in these occupations in contrast with less than 8 percent of those with such jobs in May 1937. A more striking difference between the two groups occurred in the percentages last employed in unskilled laboring work. Only 11 percent of the men with jobs were engaged in work of this type, while 22 percent of those without jobs had last been employed in unskilled work. Much larger proportions of the unemployed women than of those working reported that their last job had been in domestic- and personal-service occupations and skilled and semiskilled occupations in the manufacture of metal products. Considerably more employed than unemployed workers, both men and women, had most recently worked in clerical occupations, transportation and trade pursuits, and executive and

⁵Data concerning the last job in private industry or regular Government employment which lasted for 1 month or longer were recorded for persons unemployed in May 1937 who had been previously employed. 133 casual workers (57 men and 76 women who reported that they had never had a job of 1 month's duration) were classified as previously employed and not as new workers, but because of the casual nature of their usual employment they are excluded from tabulations of these data.

SECTION II

RECENT CHANGES IN OPERATIONS AND IN AMOUNTS OF LABOR USED IN COTTON PRODUCTION¹

THE PROCESS OF COTTON PRODUCTION

There are great differences between areas in the operations performed in raising cotton and in the frequency with which they are repeated. This wide variation in the cultural practices employed in different areas is due principally to differences in climate, topography, type of soil, size of farms, size and character of implements and type of power used, insect pests and diseases, available labor supply, and prevailing customs. There is much interrelationship between these factors. Thus, the topography affects the lay-out of fields, which in turn affects the type of power and of implements used; the size of farm affects the economical unit of motive power and through it the size of implements; and so on. All of the factors named influence, to a greater or lesser degree, the amount of labor used per acre in producing the crop.

Any description of the general process of cotton production that is complete and accurate for one section would have to be modified in many details for others. Nevertheless, a general description of the outstanding operations may be of benefit to readers not acquainted with farming practices in the South.²

There may be considerable labor expended in the cottonfield before any work is actually done in preparation of the seedbed. Stalks from last year's crop, if large, may need to be cut with a stalk cutter or knocked down by hand; the terraces are likely to need cleaning, especially if they are of the old bench type; sprouts may have to be cut in fields of wooded areas and sandy soils. Only after all this is done can the actual work on the crop begin.

The first of three periods of peak labor requirements occurs during the preparation of the seedbed. In this process the land may or may not be flatbroken or plowed with an ordinary turning

¹This section was prepared by William C. Holley.

²For a more complete description of the practices of cotton production see L. A. Moorhouse and M. R. Cooper, *The Cost of Producing Cotton* (U. S. Dept. Agr. Bull. No. 896, 1920).

plow. If flatbroken, it is usually gone over with a disk or harrow to break up clods and to prepare a friable seedbed. Following this, the farmer may lay off or mark out rows with a small shovel plow to guide him in the next operations. This is more commonly done in the eastern than the western sections. Commercial fertilizer is usually applied next in these rows with a one-horse fertilizer distributor.

The farmer then proceeds to "bed up", that is, to throw two or more furrows together with a turning plow, middlebuster, or lister, to form a ridge on which the cotton is usually planted. A minority of the farmers may even "rebed." This means plowing open the beds first made and throwing the furrows into the former depressions to form new beds. There may be other operations before the cotton is actually planted, such as opening the rows, dragging or harrowing down beds, or "sweeping out" the middles between the beds.

The cotton in eastern sections is usually planted with a one-row, one-mule planter and, if beds have been formed, it is planted on top of the ridge where the soil will warm up most quickly and give the seedlings an early start. Usually cotton in this section is planted on top of the bed but not until the bed has been dragged down by harrowing or opening a furrow (with stock and sweep) for the planter to follow.

Next begins the long process of keeping the cotton free of weeds. Cultivation or "plowing" is repeated as often as seems necessary to keep down weeds and grass.

There are various modifications of the process of "plowing" cotton to suit the season or to facilitate other operations that are being performed at the same time. Thus in the eastern sections a turning plow is used to "bar off" the rows just before chopping. This consists of plowing furrows away from the rows to leave the plants standing on narrow ridges so they will be easier to "chop." After chopping, the rows may be "sided", that is, the dirt is plowed back against the ridge. After cultivating the cotton rows themselves, there is likely to be a strip or ridge left between rows. This is torn down or cultivated by "sweeping middles."

It is also necessary to chop out or thin the young plants and later to go over the field from one to six or eight times to hoe and weed by hand. Cultivating and hoeing constitute the second

peak seasonal labor requirements and use more labor in the eastern and more humid areas than in the western areas where weeds grow less rapidly.

Another operation which may be performed during the growing season is that of spraying or dusting for control of the boll weevil and other insects.

Finally we come to the third peak in labor requirements, picking the crop. This may start as early as the middle of August in some districts and may last until the middle of December. The field may be covered from one to four times. Following picking, the cotton is weighed, since the pickers are ordinarily paid by the pound of seed cotton picked. The cotton is then hauled to the gin, and the bale may be sold or stored nearby or may be hauled back to the farm for storage until the farmer is ready to sell.

As we discuss in the following pages the amounts of labor these operations require, it will be observed that some of them are common in certain areas but are scarcely performed at all in others. It will also be noted that the number of times the crop is cultivated or hoed varies from eastern sections to the semiarid section where the weeds grow more slowly. The small, light equipment used both in preparing the seedbed and in cultivating the crop is made necessary on most farms by the small acreage of cotton raised per farm and by the irregular shape of the fields. This contributes greatly to the number of times it is necessary to go over the land in growing the crop. As larger machinery and larger power units are adopted, there is considerable opportunity to combine operations or, by doing more thorough work, to reduce the number of times some of them are repeated. The following pages will show the extent to which the various practices are used in the several sections of the cotton-raising area, the amount of labor required to perform the operations, and the changes which have taken place during the past quarter of a century. The statistical material presented was derived from the data collected in the 1936 field survey conducted by the WPA National Research Project. The data for the years prior to 1936 are based on the farmers' memory, but they have been checked against earlier studies conducted by other agencies and are believed to be reasonably accurate.³ The conclusions presented

³For a discussion of size of farms and other features of the NRP Farm Survey sample see appendix I of L. E. Macy and Others, *Changes in Technology and Labor Requirements in Crop Production: Corn* (WPA National Research Project, Report No. A-6, June 1938).

are based not only on these data but also on other information obtained from the United States Department of Agriculture, the State experiment stations, and other established sources.

SEEDBED PREPARATION

In some areas seedbed preparation begins in the late fall or early winter and is carried on intermittently, while in others very little preparation is done until early spring just prior to planting.

Preparing the Field: Cutting Sprouts and Cleaning Ditches and Terraces

Except in the Texas Black Waxy and Western Semiarid Sections, which are relatively free from timber, it is a common practice to cut sprouts, especially on newly cleared land and also on some lands in timber areas, regardless of the length of time in cultivation. Ditches for drainage and terraces, especially the old bench-type terrace, require annual cleaning and considerable work to keep in repair and free from growth of bushes.

Since 1909 there has been a slight decrease in the percentage of farmers cutting sprouts and cleaning ditches and terraces in most of the eastern sections, as shown in table 6.⁴ This may be attributed to a reduction in the amount of virgin soil placed in cultivation from decade to decade and to improved methods of clearing land in timber areas before it is placed under cultivation, to the building of new and improved terraces on which crops can be grown and cultivated, and to the improvement in drainage facilities. These factors have also reduced the labor used in the operation on the farms where it is performed by about $\frac{1}{2}$ hour per acre in the Coastal Plain and Mississippi Delta Sections.

⁴More detailed information on the practices followed and the amounts of labor used for the counties from which data were obtained for this study may be obtained from the following appendixes:

Appendix B: "Cultural Practices Followed on Farms Surveyed, 1909-38";
Appendix C: "Hours of Labor Used per Acre on Farms Surveyed, 1909-38."

These appendixes consist of 37 pages of statistical material. Since they are of interest to a relatively small number of the readers of this report, they are not published with it. 2 copies, however, were deposited in the Library of the Bureau of Agricultural Economics of the U. S. Department of Agriculture, at Washington, D. C., where they may be consulted by persons who are interested.

Tables in appendix B show, for the samples obtained from each county studied, the percentages of farmers following the practices discussed. Where there is more than 1 important method or size of implement used, separate percentages are shown for each principal method or size. Appendix B also shows the average number of times over for each principal operation, the amount of fertilizer applied per acre, and the average size of farms studied. In appendix C is shown the average number of hours spent on each operation, by counties surveyed and for the different years studied.

Table 6.- PREPARING THE FIELD: CUTTING SPROUTS AND CLEANING DITCHES AND TERRACES

Percentage of Farmers Reporting the Practice and Hours of Labor Required per Acre, 1909-36^a

Section	1909	1919	1929	1936
Percent of farmers reporting the practice				
Coastal Plain	61	61	61	61
Piedmont	66	69	66	66
Eastern Hilly	48	43	44	44
Western Hilly	93	94	89	91
Mississippi Delta	66	60	71	74
Texas Black Waxy	2	2	2	2
Western Semiarid	4	0	1	1
Hours required per acre on farms reporting the practice ^b				
Coastal Plain	2.9	2.8	2.4	2.4
Piedmont	2.4	2.3	2.5	2.5
Eastern Hilly	2.5	2.7	2.4	2.4
Western Hilly	2.8	3.0	2.8	2.8
Mississippi Delta	3.3	3.1	2.7	2.7
Texas Black Waxy	†	†	†	†
Western Semiarid	†	-	†	†
Hours required per acre, average for all farms				
Coastal Plain	1.7	1.6	1.4	1.4
Piedmont	1.6	1.6	1.6	1.6
Eastern Hilly	1.2	1.2	1.1	1.1
Western Hilly	2.6	2.8	2.5	2.5
Mississippi Delta	2.8	2.5	2.0	2.0
Texas Black Waxy	0.1	0.1	0.1	0.1
Western Semiarid	*	0	*	*

^aData obtained in MRP Farm Survey, 1936.

^bHours include all sprout cutting and ditch and terrace cleaning.

^cAverage not given for fewer than 10 cases.

^dLess than 0.05 hours.

In the remaining sections east of the Texas Black Waxy the amount of labor required by this task has remained about the same.

The amount of labor needed for this operation is highest in the recently cleared Mississippi Delta and in the Western Hilly Sections. In the Mississippi Delta and the Coastal Plain there have been appreciable declines in the amount of time spent per

acre for these purposes. An average⁵ of 2 or more hours per acre is still used, however, in the Mississippi Delta and the Western Hilly Sections, as compared with practically none in the Western Semiarid Section.

Cutting Stalks

The cropping practices in the sections studied are such that cotton generally follows cotton or corn. The stalks remaining from the old crops, especially where they are large, are usually cut with a stalk cutter or knocked down by hand with a stick or hoe before flatbreaking or bedding the land for the next crop. In some sections the stalks do not grow to a sufficient size to require cutting or knocking, but are plowed under.

Since 1909 there has been a definite trend toward the use of the stalk cutter, as shown in table 7. However, 70 percent of the farms studied in the Piedmont Section reported knocking stalks by hand even in 1936. For the most part the one-row stalk cutter is used in all sections, though the two-row stalk cutter is not uncommon in the Texas Black Wax and the Western Semiarid Sections and the three-row roller-type cutter is used extensively in the Texas Black Wax Section.

The percentage of farmers cutting stalks has decreased in most sections since 1909. The practice was reported by 10 percent fewer farmers in the Western Hilly and Mississippi Delta Sections and 17 percent fewer in the Western Semiarid Section in 1936 than in 1909. The reduction may be attributed to the growth of smaller stalks, the use by some farmers of the disk which cuts stalks and prepares the seedbed at the same time, and the use on some farms of plows large enough to turn under smaller stalks without previously breaking them down.

The use of a stalk cutter represents a substantial saving in labor as it requires not more than two-thirds as much labor as hand cutting. Except in the western sections, however, there has been no increase in the rate of performance of stalk cutters since 1909. In the Western Semiarid Section, where multiple-row machines have come into use and tractors are often used for motive power, the rate has almost doubled.

⁵Average labor requirements from the NRP Farm Survey were calculated by dividing the sum total of the hours used per acre on each farm by the number of farms surveyed in the county or section. Cases in which a smaller number of farms is used as the divisor have been designated.

Table 7.- CUTTING STALKS BY HAND AND WITH MACHINE

Percentage of Farmers Reporting the Practice and
Hours of Labor Required per Acre, 1909-36^a

Section	1909		1919		1929		1936	
	Hand	Ma- chine	Hand	Ma- chine	Hand	Ma- chine	Hand	Ma- chine
Percent of farmers reporting the practice								
Coastal Plain	27	72	20	80	19	79	20	78
Piedmont	79	12	73	19	70	21	70	20
Eastern Hilly	12	88	6	90	4	94	4	94
Western Hilly	4	74	3	77	3	66	3	65
Mississippi Delta	11	77	2	85	0	80	0	78
Texas Black Waxy	0	98	0	98	0	99	0	96
Western Semiarid	0	79	0	68	0	65	0	62
Hours required per acre on farms reporting the practice								
Coastal Plain	3.4	1.4	3.1	1.4	3.0	1.4	3.1	1.4
Piedmont	2.4	1.5	2.3	1.5	2.4	1.5	2.4	1.6
Eastern Hilly	#	1.0	#	1.0	#	1.0	#	1.0
Western Hilly	#	1.1	#	1.1	#	1.1	#	1.1
Mississippi Delta	#	1.2	#	1.3	-	1.2	-	1.2
Texas Black Waxy	-	0.9	-	0.8	-	0.6	-	0.6
Western Semiarid	-	0.9	-	0.8	-	0.6	-	0.5
Hours required per acre, average for all farms								
Coastal Plain	1.9		1.7		1.7		1.7	
Piedmont	2.1		2.0		2.0		2.0	
Eastern Hilly	1.2		1.0		1.1		1.0	
Western Hilly	0.9		0.9		0.8		0.8	
Mississippi Delta	1.4		1.1		1.0		1.0	
Texas Black Waxy	0.9		0.8		0.6		0.6	
Western Semiarid	0.7		0.5		0.4		0.3	

^aData obtained in NRP Farm Survey, 1936.

#Average not given for fewer than 10 cases.

The amount of labor used in cutting or knocking stalks is highest in the Piedmont Section, where they are most often knocked by hand, and where an average of 2 hours per acre was reported. In the eastern sections there has been relatively little change in amount of labor used for this operation. In the Mississippi Delta, Black Waxy, and Western Semiarid Sections, however, where mechanization had advanced most rapidly, the time used has declined 30 to 60 percent.

Flatbreaking or Plowing

Where cotton follows small grain or a sod-forming crop, the practice of flatbreaking or plowing with a common turning plow in the fall is frequently followed. Usually, where cotton follows another cultivated crop, the practice of flatbreaking, if followed, is done in the spring. Probably the principal reasons for flatbreaking in the spring are that previous crops generally are harvested too late in the fall to permit flatbreaking, and that in some sections, especially those where soils are of a

Table 8.- FLATBREAKING OR PLOWING

Percentage of Farmers Reporting the Practice and
Hours of Labor Required per Acre, 1909-36^a

Section	1909	1919	1929	1936
Percent of farmers reporting the practice				
Coastal Plain	66	67	68	68
Piedmont	48	42	44	44
Eastern Hilly	88	90	92	92
Western Hilly	57	55	56	54
Mississippi Delta	57	60	47	50
Texas Black Wax	7	15	18	14
Western Semiarid	42	28	30	27
Hours required per acre on farms reporting the practice				
Coastal Plain	6.0	6.0	5.8	5.7
Piedmont	6.8	7.2	7.1	7.3
Eastern Hilly	5.8	5.4	5.4	5.4
Western Hilly	5.3	4.9	4.9	4.8
Mississippi Delta	4.5	4.8	3.5	3.2
Texas Black Wax	†	†	3.7	2.5
Western Semiarid	3.1	2.2	1.8	1.6
Hours required per acre, average for all farms				
Coastal Plain	4.0	4.0	4.0	3.8
Piedmont	3.3	3.0	3.1	3.2
Eastern Hilly	5.0	4.9	5.0	5.0
Western Hilly	3.1	2.7	2.7	2.6
Mississippi Delta	2.8	2.9	1.7	1.6
Texas Black Wax	0.4	0.4	0.6	0.4
Western Semiarid	1.3	0.6	0.5	0.5

^aData obtained in NRP Farm Survey, 1936.

†Average not given for fewer than 10 cases.

sandy nature, vegetation grows profusely in the early spring and in these areas spring plowing tends to insure a clean seedbed as well as to add organic matter to the soil.

The percentage of farmers flatbreaking in the eastern sections is higher than in the Black Wax or Western Semiarid Sections. The differences are due largely to the differences in type of soil and the degree of infestation of weeds.

The amount of labor spent in plowing an acre of land varied between sections with the size of plow and amount of power used. In the Western Semiarid Section no one-horse plows were reported in the counties studied; here an acre of land was plowed in about 1½ hours in 1936. In the sections to the east about 40 percent of all plows were one-bottom, one-horse plows, and about 5 hours are needed to plow an acre. In the eastern sections only 1 percent of the plows reported, even in 1936, were drawn by tractors, while in the western sections 31 percent were drawn by tractors in 1936. These percentages, however, do not indicate the proportion of farms with tractor plows, since there were often two or more plows on the same farm. In the Western Semiarid Section the use of tractors and larger horse-drawn machines has cut in half the time required to plow an acre since 1909. East of the Mississippi Delta tractors and larger plows have been slow to come into use, and the average amount of time needed to plow an acre has decreased but little.

The amount of labor needed for plowing varies with the proportion of farmers performing the operation, as well as with the type of equipment used. Thus, the average number of hours spent in flatbreaking land varied from 5.0 in the Eastern Hilly Section, where this practice was performed by 92 percent of the farmers (about 40 percent of whom used one-horse plows), to 0.5 in the Western Semiarid Section where only 27 percent plowed in 1936 and 31 percent of these used tractor plows.

Disking

Disking is not a common practice in preparing the seedbed for cotton. The disk requires considerable power if it is to do a good job, whereas the most common power outfits in most of the Cotton Belt consist of one or two mules. Also, where the soil is easily worked the disk is often not needed, for the seedbed may be prepared directly with the lister without previous plowing

or disking. The disk, however, helps materially where the soil is lumpy or where weeds and grass grow abundantly.

Disking is done on one-third to one-half of the farms in the Coastal Plain, Western Hilly, and Mississippi Delta Sections, as shown in table 9. The single disk is most commonly used,

Table 9.- DISKING

Percentage of Farmers Reporting the Practices and
Hours of Labor Required per Acre, 1909-36^a

Section	1909	1919	1929	1936
Percent of farmers reporting the practice				
Coastal Plain	30	34	37	35
Piedmont	10	9	9	7
Eastern Hilly	2	12	10	10
Western Hilly	36	34	33	34
Mississippi Delta	26	30	50	49
Texas Black Wax	5	4	11	12
Western Semiarid	20	12	8	8
Hours required per acre to disk once				
Coastal Plain	1.4	1.4	1.4	1.3
Piedmont	†	1.6	1.6	†
Eastern Hilly	†	†	†	†
Western Hilly	1.6	1.6	1.5	1.4
Mississippi Delta	†	1.2	0.8	0.6
Texas Black Wax	†	†	†	†
Western Semiarid	†	1.0	0.8	0.6
Hours required per acre for all disking, average for all farms				
Coastal Plain	0.5	0.5	0.6	0.6
Piedmont	.2	.2	.1	.1
Eastern Hilly	.1	.2	.2	.2
Western Hilly	.5	.5	.5	.5
Mississippi Delta	.4	.5	.6	.5
Texas Black Wax	*	*	.1	.1
Western Semiarid	.3	.2	.1	.1

^aData obtained in NRP Farm Survey, 1936.

†Average not given for fewer than 10 cases.

*Less than 0.05 hours.

although the tandem disk pulled by a tractor has appeared in increasing numbers since 1919. The acreage to be worked largely determines the power outfit available, and this affects the size

and type of implement chosen. In the eastern sections a majority of the disks are drawn by two horses and are from 4 to 6 feet wide, while in the Black Waxy and the Western Semiarid Sections most of the disks are of greater working width and are drawn by four horses or by a tractor.

Harrowing

The harrow is used widely but not universally in pulverizing the soil for the seedbed. In some cases land is harrowed immediately after flatbreaking, but usually not until just prior to

Table 10. - HARROWING
Percentage of Farmers Reporting the Practice and
Hours of Labor Required per Acre, 1909-36^a

Section	1909	1919	1929	1936
Percent of farmers reporting the practice				
Coastal Plain	67	67	66	68
Piedmont	71	77	73	72
Eastern Hilly	71	69	71	71
Western Hilly	91	89	87	87
Mississippi Delta	100	100	95	95
Texas Black Waxy	75	74	76	74
Western Semiarid	62	36	26	28
Hours required per acre to harrow ^b once				
Coastal Plain	1.3	1.3	1.3	1.3
Piedmont	1.7	1.8	1.7	1.7
Eastern Hilly	1.2	1.2	1.2	1.2
Western Hilly	1.0	1.0	0.9	0.9
Mississippi Delta	1.0	1.0	0.8	0.8
Texas Black Waxy	0.8	0.7	0.6	0.6
Western Semiarid	0.5	0.5	0.3	0.3
Hours required per acre for all harrowing, ^b average for all farms				
Coastal Plain	1.0	1.1	1.0	1.0
Piedmont	1.3	1.4	1.3	1.3
Eastern Hilly	0.9	0.8	0.8	0.8
Western Hilly	0.9	0.8	0.8	0.8
Mississippi Delta	1.1	1.1	1.0	1.0
Texas Black Waxy	0.6	0.6	0.5	0.4
Western Semiarid	0.4	0.2	0.1	0.1

^aData obtained in NRP Farm Survey, 1936.

^bIncludes a small amount of dragging.

planting. The spike-tooth harrow is the most common type, but a small percentage of the farmers use a spring-tooth harrow or a log drag.

There has been no pronounced change in the percentage of farmers using harrows during the period covered by this study, except in the Western Semiarid Section, where the number of farmers following the practice has declined by more than one-half. This reduction has been connected with the adoption of other implements which have displaced the harrow for some purposes. Except in the western sections where the amount of harrowing has declined and tractors and larger harrows have come into use, the amount of labor used per acre in harrowing has not changed appreciably since 1909. On the basis of all farms an average of about 1 hour per acre is used from the Mississippi Delta eastward and less than $\frac{1}{2}$ hour in the western sections.

Bedding and Rebedding

Bedding is the practice of throwing two or more furrows together for the purpose of forming a ridge, as stated previously. Where the land is not flatbroken, bedding is often the first operation after stalk cutting. Rebedding follows in some sections just prior to planting, leaving a seedbed friable and free from vegetation. In rebedding, a new ridged surface is thrown up between the old beds.

The one- and two-horse turning or moldboard plow is used extensively by farmers in the Piedmont and Coastal Plain Sections. All the farms surveyed in Tallapoosa County, Alabama, in the Piedmont Section, reported using this implement in all periods. Farmers in the Eastern Hilly, Western Hilly, and Mississippi Delta Sections used this implement on a small scale, while the middlebuster (lister) was universally used in the Texas Black Waxy and Western Semiarid Sections.

In Marshall County, Alabama, in the Eastern Hilly Section, the practice of bedding declined between 1909, when 71 percent of the farmers used it, and 1936, when it was reported by 55 percent. Changes elsewhere in the proportion of farmers performing the operation were small.

A definite trend toward the use of the middlebuster for bedding is evident throughout the eastern and central portion of the Cotton Belt and particularly in the Eastern Hilly, Western Hilly,

and Mississippi Delta Sections. The middlebuster usually requires more power than the small turning plows which it is replacing, and it covers ground at a faster rate. This shift and the use of larger implements and power units in the West have brought about a decrease in the amount of labor used in bedding on the farms where it is practiced, as shown in table 11. In consequence, the amount of labor required for the operation per acre of cotton grown has declined to some degree in all of the sections studied.

Table 11.- BEDDING AND REBEDDING
Percentage of Farmers Reporting the Practice and
Hours of Labor Required per Acre, 1909-36^a

Section	1909		1919		1929		1936	
	Bed	Re-bed	Bed	Re-bed	Bed	Re-bed	Bed	Re-bed
Percent of farmers reporting the practice								
Coastal Plain	92	18	94	17	93	17	93	17
Piedmont	98	9	99	9	99	11	99	10
Eastern Hilly	71	14	67	10	55	5	55	5
Western Hilly	89	36	91	39	85	40	83	42
Mississippi Delta	85	20	95	22	95	27	95	35
Texas Black Waxy	100	34	100	34	94	29	94	36
Western Semiarid	75	4	86	1	88	2	84	2
Hours required per acre on farms reporting the practice ^b								
Coastal Plain	4.6		4.7		4.5		4.5	
Piedmont	6.8		7.0		6.5		6.4	
Eastern Hilly	4.5		3.8		3.5		3.5	
Western Hilly	3.7		3.5		3.4		3.4	
Mississippi Delta	4.3		4.1		3.1		2.7	
Texas Black Waxy	2.2		2.1		1.9		1.8	
Western Semiarid	1.3		1.1		0.8		0.7	
Hours required per acre, average for all farms								
Coastal Plain	4.3		4.5		4.1		4.1	
Piedmont	6.7		6.9		6.4		6.4	
Eastern Hilly	3.2		2.8		1.9		1.9	
Western Hilly	3.2		3.2		2.9		2.8	
Mississippi Delta	4.0		3.9		2.9		2.6	
Texas Black Waxy	2.2		2.1		1.8		1.7	
Western Semiarid	0.9		1.0		0.7		0.6	

^aData obtained in NRP Farm Survey, 1936.

^bHours include all bedding and rebedding.



Bureau of Agricultural Economics, U.S.D.A.

FIGURE 9.- BEDDING UP WITH 1-HORSE TURNING PLOW
The picture was taken in the hilly section of Georgia.

Taking the Cotton Belt as a whole, bedding ranks with flat-breaking as a labor-consuming operation. In 1936 it required an average of 6.4 hours per acre on the farms studied in the Piedmont Section, and nearly 3 hours in the Western Hilly and Mississippi Delta Sections.

Laying Off Rows

In the three eastern sections it is common, when the land is flatbroken, to lay or mark off rows as a guide for bedding or planting. The marking is usually performed with a small shovel plow. There has been a slight increase in the performance of this operation since 1909 in the eastern sections. The practice is seldom followed in sections from the Mississippi Delta westward, as is shown in table 12.

In the three eastern sections, where the rows are marked off by about one-half the growers, the amount of time spent on this operation averages slightly under 1 hour per acre, and there has been no appreciable change since 1909. Slight declines in hours used per acre on farms reporting the practice have been offset by an increase in the proportion of farmers laying off rows.

Table 12.- LAYING OFF ROWS

Percentage of Farmers Reporting the Practice and
Hours of Labor Required per Acre, 1909-36^a

Section	1909	1919	1929	1936
Percent of farmers reporting the practice				
Coastal Plain	47	53	59	53
Piedmont	39	37	40	41
Eastern Hilly	33	37	46	46
Western Hilly	11	13	18	17
Mississippi Delta	3	2	4	3
Texas Black Waxy	0	0	6	6
Western Semiarid	0	1	*	1
Hours required per acre on farms reporting the practice				
Coastal Plain	1.7	1.6	1.6	1.6
Piedmont	2.0	2.0	2.0	2.0
Eastern Hilly	1.8	1.8	1.6	1.6
Western Hilly	1.6	1.6	1.4	1.4
Mississippi Delta	†	†	†	†
Texas Black Waxy	-	-	†	†
Western Semiarid	-	†	†	†
Hours required per acre, average for all farms				
Coastal Plain	0.8	0.9	0.8	0.8
Piedmont	0.8	0.8	.8	.8
Eastern Hilly	0.6	0.6	.7	.7
Western Hilly	0.2	0.2	.3	.2
Mississippi Delta	0.1	*	.1	*
Texas Black Waxy	0	0	*	*
Western Semiarid	0	*	*	*

^aData obtained in NRP Farm Survey, 1936.

†Average not given for fewer than 10 cases.

*Less than 0.5 percent or 0.05 hours.

Distributing Fertilizer

Commercial Fertilizer.- Commercial fertilizers were used on practically all the cotton farms surveyed in the Piedmont, Eastern Hilly, and Coastal Plain Sections, except those in Madison County, Mississippi. Approximately 50 percent of the farmers in the Western Hilly Section and one-fourth of those in the Mississippi Delta used fertilizer, as is shown in table 13. Commercial fertilizers were not used on the farms surveyed in the Texas Black Waxy and Western Semiarid Sections.

Table 13.- APPLYING COMMERCIAL FERTILIZER

Percentage of Farmers Reporting the Practice and
Hours of Labor Required per Acre, 1909-36^a

Section	1909	1919	1929	1936
Percent of farmers reporting the practice ^b				
Coastal Plain	81	84	88	86
Piedmont	98	99	99	100
Eastern Hilly	98	99	99	99
Western Hilly	41	64	62	50
Mississippi Delta	14	12	14	67
Hours required per acre on farms reporting the practice ^b				
Coastal Plain	2.5	2.5	2.5	2.4
Piedmont	2.9	2.7	2.7	2.6
Eastern Hilly	2.6	2.9	3.0	2.6
Western Hilly	1.6	1.7	2.0	1.6
Mississippi Delta	#	#	2.0	1.1
Hours required per acre for application of commercial fertilizer and manure, average for all farms				
Coastal Plain	3.1	3.3	3.2	3.3
Piedmont	3.4	3.6	3.3	3.3
Eastern Hilly	6.0	7.0	6.9	6.4
Western Hilly	2.2	2.5	2.2	1.9
Mississippi Delta	0.8	0.7	1.5	2.3

^aData obtained in NRP Farm Survey, 1936. No farms in the Texas Black Wax and Western Semiarid Sections reported application of either fertilizer or manure in any of the years.

^bIncludes all farms applying commercial fertilizer either at time of planting or as side dressing.

^cAverage not given for fewer than 10 cases.

The percentage of farmers interviewed who applied commercial fertilizer has increased little since 1909, except in the Mississippi Delta. Here there was a pronounced increase in the number of farmers applying fertilizer in 1936 over that in earlier years. In the Western Hilly Section more of the farmers interviewed used fertilizer in 1919 than in either the earlier or the later years studied. On the farms surveyed in these two sections the cotton acreage fertilized per farm has increased since 1909 by 36 percent and 20 percent respectively.

On the majority of farms studied, the fertilizer was applied with a one-row distributor, but a small percentage was applied by hand or with two-row machines. Since 1909 the trend has been definitely toward the use of the distributor.



Alabama Extension Service

FIGURE 10.— LAYING OFF ROWS, FERTILIZING, AND BEDDING

The man to the right is laying off rows and distributing fertilizer in one operation. The man to the left is bedding on top of the fertilizer with two mules hitched to a mangle.

Ordinarily on sandy soils fertilizer is distributed just prior to planting but it may be applied earlier on heavy soils. A few farmers in the Mississippi Delta reported the distribution of fertilizer in the late fall.

Results of fertilizer experiments and changes in the plant-food content of commercial fertilizer will be discussed in section IV.

Side Dressing.— This term refers to the application of fertilizer at the side of the row after the cotton plants have attained some size. Ordinarily this application is by hand, except in the Eastern Hilly and Mississippi Delta Sections, where the distributor has supplanted hand distribution.

The average number of pounds applied per acre on the farms surveyed has changed but little since 1909. The time required to apply commercial fertilizer to an acre of cotton depends not only on the method used but also on whether one or two applications are made. As shown in table 13, the labor used for this operation on the farms where commercial fertilizers were used tended to increase prior to 1929. This was due largely to the greater number making two applications, one at the time of planting and another during the growing season. After 1929, increased use of fertilizer distributors reduced the amount of labor used.

Applying Manure.— The application of manure ranged from an average of 1 to 3 tons per acre on farms where used. All farmers reporting this practice distributed the manure by hand. The most common crew consisted of two men and two mules, although some of the manure spreading was done by one man and one mule.

Although the percentage of farmers applying manure varies widely, the percentage of the cotton acreage manured was very small. The highest percentage was reported in the Eastern Hilly Section, where manure was applied by 9 percent of the farmers in 1909 as compared with 11 percent in 1936.

The average amount of labor used in applying fertilizer and manure on all farms has not changed appreciably since 1909 except in the Mississippi Delta. Here an increase of from 0.8 to 2.3 hours per acre is shown in table 13. In the Coastal Plain and the Piedmont Sections an average of 3.3 hours per acre was used in 1936. In the Eastern Hilly Section, where the highest percentage of farmers applied manure, the time spent in all fertilizing averaged 6.4 hours.

PLANTING

Discoveries Regarding the Spacing of Cotton Plants⁶

The advent of the cotton boll weevil made it necessary for the cotton grower to produce a crop in a relatively short season. In the early years of the boll-weevil invasion it was considered desirable to plant cotton in wide rows with wide spacing of plants in the row, that is, 18 to 24 inches or more.⁷ The object was to allow more sunlight between rows and between plants in order to kill the weevil grubs in the squares or bolls which had fallen off the plants.

In 1913 a new system of cotton culture based on the control of vegetative branches was advocated. Thinning was delayed and plants were left closer together, one stalk to a hill, in order to restrict formation of vegetative branches and to induce earlier development of fruiting branches.⁸ It was found later, however, that delayed thinning to one stalk to a hill decreased instead of increased the yield by an amount ranging from about 5 to

⁶This material was prepared by Lloyd E. Arnold.

⁷R. J. Redding, *Essential Steps in Securing an Early Crop of Cotton* (U. S. Dept. Agr. Farmers' Bull. No. 217, 1905), pp. 11-3.

⁸O. F. Cook, *A New System of Cotton Culture* (U. S. Dept. Agr., Bur. Plant Industry Circ. No. 115, 1913), p. 15.

nearly 30 percent.⁹ To control vegetative branches, much closer spacing than in earlier years is now advised, with two or more plants per hill 12 to 14 inches apart. In the semiarid region it is not uncommon to find cotton planted in relatively wide rows, spaced 2 to 4 inches apart, and never thinned.¹⁰ The effect of "thick spacing" on earliness of the crop is well demonstrated in experimental data from Arkansas where 51,000 plants per acre produced 48 percent of the total harvested crop at the first picking; 23,000 plants per acre, 47 percent; and 10,000 plants per acre, only 39 percent.¹¹ Maximum yield of cotton for various spacings will vary from one area to another. Data for Alabama indicate that 18-inch hills with one, two, or three plants per hill give maximum yields, while in Arkansas there is some tendency for highest yields to be obtained with closer spacings.

Since it has become known that more plants per acre mean higher yields, progressive farmers have begun to reduce the width of the rows. Thus in 1926, 44 percent of the participants in the cotton contests in South Carolina planted their cotton in rows 47 to 49 inches wide; by 1936 only 10 percent were placing rows this far apart. On the other hand, the row widths of 30-34, 35-37, and 38-40 inches increased from 0 to 9, 5 to 20, and 4 to 20 percent respectively. The decrease in row width, as indicated by these contests, has also been carried into general cotton production and has undoubtedly had some effect on the average yield of the State.¹²

Practice in Planting on Farms Surveyed

In all the counties studied, cotton was planted on a slightly raised bed, except in the Western Semiarid Section, where it is usually planted about 3 inches below the surface level in order to get the seed down in moist soil. The one-row planter is almost universally used in the Piedmont, the Coastal Plain, and the Eastern and Western Hilly Sections. Since 1909 there has been a definite shift from the one-row to the two- and four-row planters in the Mississippi Delta, Texas Black Waxy, and Western Semiarid Sections, as shown in table 14.

⁹ H. B. Brown, *Cotton Spacing* (Miss. Agr. Expt. Sta. Bull. No. 212, 1923), pp. 12-5.

¹⁰ F. Cook, "Cotton More Productive When Thick Spaced for Small Upright Plants," *Yearbook of Agriculture: 1931* (U. S. Dept. Agr., 1931), p. 167.

¹¹ J. O. Ware, *Cotton Spacing, II, Effect on Blooming, on Earliness, Fruit Set and Yield* (Ark. Agr. Expt. Sta. Bull. No. 253, 1930), p. 63.

¹² R. W. Hamilton and B. E. G. Prichard, *The Cotton Contest . . . 1936* (Clawson Agr. College Ext. Service Circ. No. 156, 1937), p. 8.

Cotton seed is generally planted many times more thickly than the plants are allowed to grow, and plants are thinned when they are from 3 to 5 inches high. In the Western Semiarid Section, however, some farmers plant only enough seed to insure a good stand, thus eliminating thinning. In 1936 the average amount of seed planted per acre ranged from approximately 36 pounds in the Mississippi Delta to approximately 16 pounds in the Western Semiarid Section. These figures represent slight decreases since 1909.

The distance between cotton rows ranged from 36 inches in the Texas Black Waxy Section to 42 inches in the Eastern Hilly Section. Although the more progressive farmers, like those participating in the cotton contests, have planted their rows closer together in recent years, the change in the general average has been relatively small.

Table 14.- PLANTING
Percentage of Farmers Reporting, by Size of Planters,
and Hours of Labor Required per Acre, 1909-36^a

Section	Row width of planter in -							
	1909		1919		1929		1936	
	One	Two or more	One	Two or more	One	Two or more	One	Two or more
	Percent of farmers reporting							
Coastal Plain	100	0	100	0	100	0	100	0
Piedmont	100	0	100	0	100	0	100	0
Eastern Hilly	100	0	100	0	100	0	100	0
Western Hilly	100	0	100	0	97	3	97	3
Mississippi Delta	98	2	90	10	79	21	75	25
Texas Black Waxy	100	0	100	0	72	28	55	45
Western Semiarid	100	0	88	12	31	69	18	84
	Hours required per acre							
Coastal Plain	1.6		1.6		1.6		1.6	
Piedmont	2.0		2.0		2.0		2.0	
Eastern Hilly	1.6		1.6		1.5		1.5	
Western Hilly	1.7		1.7		1.6		1.6	
Mississippi Delta	1.3		1.3		1.2		1.2	
Texas Black Waxy	1.5		1.5		1.2		1.1	
Western Semiarid	1.2		1.1		0.8		0.6	

^aData obtained in NRP Farm Survey, 1936.



Bureau of Agricultural Economics, U.S.D.A.

FIGURE 11.— PREPARING LAND AND PLANTING COTTON IN SOUTH CAROLINA

Between plants in the row, the average distance found on farms studied in 1936 ranged from 6 inches in the Western Semiarid Section to 12 inches in the Coastal Plain Section. Some tendency toward closer spacing in the row has been observable since 1909.

Labor Requirements in Planting

Table 14 shows that the greatest amount of labor used in planting an acre of cotton was found in the Piedmont region and amounted to 2.0 hours per acre. In the Coastal Plain and the Eastern and Western Hilly Sections about 1.6 hours were used on an average, with only slight declines since 1909. In the Mississippi Delta and in the Black Waxy Sections, where larger machinery has come into use on at least a good fraction of the plantations, 1.2 and 1.1 hours respectively were used. And in the Western Semiarid Section, where two- and four-row planters have become the rule rather than the exception, planting required only 0.6 hour per acre in 1936 as compared with 1.2 hours in 1909.

CULTIVATION

Discoveries Regarding the Need for Cultivation

Experimental evidence within recent years has brought about a change in the point of view regarding the number of cultivations needed to produce a maximum crop. Among farmers, however,

the old belief that the crop should be cultivated as often as possible has persisted longer than might have been expected. The experimental evidence shows that a large number of cultivations are not necessary, providing weeds can be controlled with fewer operations. In South Carolina, with normal cultivation, the yield of seed cotton was 925 pounds; with continued late cultivation, 873 pounds; and with no cultivation, but with the weeds scraped off with a hoe, 889 pounds. In Georgia, cotton with normal cultivation yielded 1,012 pounds and with no cultivation other than removing weeds with a hoe, 1,099 pounds.¹³

In other words, cotton needs cultivation only often enough to control weeds. More frequent operations merely add to the expense of producing the crop and, in some instances, may even reduce the yield.

Farm Practice in Cultivation

In spite of the evidence that cultivation is needed only for the purpose of killing weeds, there has been no general decrease in the average number of times farmers have cultivated cotton in the areas studied; in fact, there has been a slight increase. Of course, it is possible that there could not be much of a reduction from the present practice without permitting greater weed growth. But there is considerable variation in the number of times farmers cultivate in the same locality, suggesting an opportunity for reduction of this work by some of them.

In 1936 the average number of cultivations ranged from 7.8 in the Mississippi Delta, where rich soil and frequent rainfall make for rapid weed growth, to 3.9 in the Western Semiarid Section where weeds are few.

In the Coastal Plain and Eastern Hilly Sections about 80 percent of the farmers interviewed reported the use of one-half-row implements for cultivating cotton in 1936, and those in the Piedmont used this size almost exclusively. However, the percentage of farmers using the one-row cultivator has increased 5 percent since 1909 in the Coastal Plain and 7 percent in the Eastern Hilly Sections.

Two-thirds of the farmers interviewed in the Western Hilly Section reported the use of the one-row cultivator exclusively

¹³C. P. Blackwell and T. S. Bute, *Cotton Production* (S. C. Agr. Expt. Sta. Bull. No. 219, 1924), p. 34; R. P. Bledsoe, *Cotton Fertilizer and Cultural Methods* (Ga. Expt. Sta. Bull. No. 152, 1929), p. 29.



WFA - National Research Project

FIGURE 12.- STOCK EQUIPPED WITH SWEEPS USED FOR CULTIVATING COTTON IN DARLINGTON COUNTY, SOUTH CAROLINA

in 1936, compared with 54 percent in 1909. Twenty-six percent of the farmers in this section reported the use of one-half-row and one-row equipment on the same farm.

The farmers in the Mississippi Delta used a variety of cultivator sizes in 1936. Nine percent reported the use of one-half-row implements; 37 percent reported one-row equipment; 35 percent used both one-half- and one-row equipment on the same farm; and 19 percent used two- or four-row cultivators. The use of one-half-row equipment for all cultivations has decreased about one-half since 1909. There has been an increase of about

one-fourth in the number of farmers using both one-half-row and one-row equipment.¹⁴

In the Texas Black Waxy Section about 40 percent of the farmers interviewed reported the use of two- and four-row cultivators in 1936, whereas all were using one-row equipment in 1909.

The greatest shift from the one-row to the two- and four-row cultivator took place in the Western Semiarid Section. Here the change was made by 78 percent of the farmers, as shown in table 15.



Bureau of Agricultural Economics, U.S.D.A.

FIGURE 19.— CULTIVATING COTTON WITH 2-HORSE, 1-ROW CULTIVATOR
IN THE MISSISSIPPI DELTA SECTION

Labor Requirements in Cultivation

The advantage of multiple-row cultivators is evident from the data presented in table 15. In 1936 it took the average farmer in the Piedmont Section as much time to cultivate an acre once as was required in the Western Semiarid Section to go over 7½ acres. In the former section 98 percent of the farms had cultivators less than one row wide, while in the latter 82 percent

¹⁴See table B-2.

Table 15.- CULTIVATING
Percentage of Farmers Reporting, by Size of Cultivator,
Frequency of Cultivation, and Hours of Labor
Required per Acre, 1909-36^a

Section	1909	1919	1929	1936
Percent of farmers using cultivators larger than 1-row ^b				
Coastal Plain	13	14	18	18
Piedmont	2	2	2	2
Eastern Hilly	14	22	25	21
Western Hilly	77	87	97	98
Mississippi Delta	81	73	88	91
Texas Black Waxy	100	100	100	100
Western Semiarid	100	100	100	100
Percent of farmers using 2-row or larger cultivators ^c				
Western Hilly	0	0	1	3
Mississippi Delta	0	0	14	19
Texas Black Waxy	0	0	26	40
Western Semiarid	4	16	69	82
Average number of times cultivated				
Coastal Plain	5.2	5.3	5.3	5.3
Piedmont	4.6	4.7	4.8	4.7
Eastern Hilly	5.3	5.3	5.3	5.3
Western Hilly	4.8	4.8	4.9	4.8
Mississippi Delta	7.3	7.5	7.7	7.6
Texas Black Waxy	4.9	4.9	4.9	4.9
Western Semiarid	3.2	3.7	3.7	3.7
Hours required per acre to cultivate once				
Coastal Plain	3.9	3.8	3.8	3.5
Piedmont	4.7	4.6	4.6	4.5
Eastern Hilly	3.5	3.5	3.3	3.3
Western Hilly	3.2	3.2	2.9	2.8
Mississippi Delta	2.6	2.4	2.1	2.0
Texas Black Waxy	1.5	1.5	1.2	1.1
Western Semiarid	1.3	1.1	0.8	0.8
Hours required per acre for all cultivating				
Coastal Plain	19.7	19.5	18.7	18.7
Piedmont	21.5	21.5	20.8	20.8
Eastern Hilly	18.9	18.5	17.8	17.6
Western Hilly	14.9	14.4	13.8	13.2
Mississippi Delta	19.3	18.4	16.5	15.2
Texas Black Waxy	7.6	7.4	6.1	5.6
Western Semiarid	4.4	4.1	3.0	2.3

^aData obtained in NRP Farm Survey, 1936.

^bPercent using cultivators larger than the 1-mule size. The figures include some farmers who used both 1-mule cultivators and larger ones.

^cNo cultivators this large reported in the Coastal Plain, Piedmont, or Eastern Hilly Sections.

had cultivators two rows or wider. There has been a slight increase in the average performance of cultivators in the eastern sections and a more pronounced one in the western sections, where the shift to wider cultivators has been more rapid.

In 1936 the number of hours used per acre for all cultivations ranged from 2.3 hours in the Western Semiarid Section to 20.8 hours in the Piedmont. The time required per acre varies with the size of equipment used, the frequency of cultivation, and the character of the soil. In the Western Section all these factors were favorable to accomplishing the needed work in the shortest possible time. In the Piedmont the clay soil and the almost exclusive use of one-mule cultivators called for a greater number of hours than was necessary in the adjacent Coastal Plain. In the latter section 18 percent of the farmers used larger equipment and the light, sandy soil permitted the team to step more rapidly.

Since 1909 there has been a decline of only about 1 hour per acre in cultivating cotton in the eastern sections. In the Mississippi Delta, Black Waxy, and Western Semiarid Sections, however, the reduction has been much greater.

HOEING AND CHOPPING

As previously indicated, cotton is seeded thickly in most sections, and the plants are thinned when they attain a height of from 3 to 5 inches. A worker goes over the field, usually with a hoe, chopping out the plants to the desired distance between hills and at the same time removing grass and weeds from the row. Hoeing consists chiefly of cutting out weeds and grass which are not destroyed by cultivation or chopping. Chopping is performed once, while the number of hoeings varies considerably between sections, from an average of 0.8 times over in the Western Semiarid to 1.7 times over in the Eastern Hilly and Texas Black Waxy Sections.

Next to picking, chopping and hoeing are the most time-consuming operations in producing the crop. Combined, they account for nearly half the total labor prior to harvest, and but little change has occurred since 1909. Differences in hours were found chiefly between sections rather than between years. In the Mississippi Delta, where weeds grow abundantly, we find 34.0 hours per acre used in hoeing and chopping in 1936, as shown in table 16. In the drier Texas Black Waxy Section these operations



Bureau of Agricultural Economics, U.S.D.A.

FIGURE 14.— CHOPPING COTTON

required 14.3 hours, and in the Western Semiarid Section only 6.1 hours were used. It may be noted, by way of contrast, that chopping and hoeing in the Mississippi Delta required more labor in 1936 than did the entire process of raising and picking the crop in the Western Semiarid Section.

Hoeing is not only one of the peak labor requirements in the production of cotton, it is also one of the operations for which no satisfactory mechanical method has been developed. Check-row planting to permit cross cultivation and the use of better cultivating equipment may be expected to reduce somewhat the need for hoeing. The use of larger cultivators, however, will require the use of larger power outfits than the one-mule unit common in most producing areas.

BUSTING AND SPRAYING

A small percentage of the farmers interviewed in all sections studied, except in the Western Semiarid, reported some dusting or spraying for boll-weevil and leafworm control. Methods vary widely. Dusting by hand or from the back of a mule¹⁵ ridden

¹⁵A worker rides the mule and holds balanced across the mule's back a pole about 5 feet in length to which sacks containing dust are tied directly over the rows to be dusted. The movement of the mule joggling along distributes the dust to the plants.

Table 16.- HOEING AND CHOPPING

Number of Times Over and Hours of Labor
Required per Acre, 1909-36^a

Section	1909	1919	1929	1936
Number of times over				
Coastal Plain	2.6	2.7	2.6	2.6
Piedmont	2.3	2.4	2.3	2.3
Eastern Hilly	2.6	2.8	2.7	2.7
Western Hilly	2.2	2.2	2.2	2.2
Mississippi Delta	2.8	2.9	3.1	3.1
Texas Black Waxy	2.7	2.6	2.6	2.7
Western Semiarid	1.9	1.8	1.8	1.8
Hours required per acre for one time over				
Coastal Plain	10.3	10.3	10.3	10.3
Piedmont	10.4	10.4	10.5	10.4
Eastern Hilly	9.9	9.9	9.9	9.9
Western Hilly	9.5	9.5	9.5	9.5
Mississippi Delta	11.1	11.1	11.1	11.1
Texas Black Waxy	5.4	5.4	5.5	5.5
Western Semiarid	3.7	3.5	3.4	3.4
Hours required per acre for all times over, average for all farms				
Coastal Plain	27.6	27.9	27.6	27.6
Piedmont	23.6	24.9	24.5	23.4
Eastern Hilly	27.5	27.7	26.9	26.3
Western Hilly	20.9	21.3	21.5	21.2
Mississippi Delta	31.4	32.8	33.8	34.0
Texas Black Waxy	14.6	14.3	14.2	14.3
Western Semiarid	6.8	6.4	6.2	6.1

^aData obtained in NRP Farm Survey, 1936.

between the rows are the most common methods used in the Piedmont, Coastal Plain, and Eastern Hilly Sections. These methods require a large amount of labor and are far less effective than the machine, which requires less labor. Dusting by machine and from muleback are the most common methods found in the Western Hilly Section. In the Mississippi Delta and Texas Black Waxy Sections the machine is used almost universally.

A relatively small percentage of farmers actually take measures to combat the boll weevil, as is shown by the figures in table 17. In the Delta Section, where dusting and spraying is most

Table 17.- DUSTING AND SPRAYING

Percentage of Farmers Reporting the Practice and
Hours of Labor Required per Acre, 1909-36^a

Section	1909	1919	1929	1936
Percent of farmers reporting the practice				
Coastal Plain	2	5	14	13
Piedmont	2	11	21	10
Eastern Hilly	5	14	22	16
Western Hilly	7	15	28	24
Mississippi Delta	9	15	33	33
Texas Black Waxy	12	14	24	16
Western Semiarid	0	0	0	0
Hours required per acre to dust or spray once				
Coastal Plain	‡	2.1	1.9	1.7
Piedmont	‡	2.0	2.0	2.5
Eastern Hilly	‡	‡	2.5	2.1
Western Hilly	‡	1.3	1.2	0.9
Mississippi Delta	‡	‡	0.9	0.8
Texas Black Waxy	‡	‡	0.9	0.8
Western Semiarid	-	-	-	-
Hours required per acre for all dusting and spraying, average for all farms				
Coastal Plain	*	0.2	0.7	0.4
Piedmont	*	0.9	1.4	0.8
Eastern Hilly	0.1	0.6	1.0	0.7
Western Hilly	0.1	0.4	0.5	0.3
Mississippi Delta	0.1	0.4	1.0	0.7
Texas Black Waxy	0.3	0.2	0.5	0.3
Western Semiarid	0	0	0	0

^aData obtained in NRP Farm Survey, 1936.

‡Average not given for fewer than 10 cases.

*Less than 0.05 hours.

common, only 33 percent of the farmers reported the practice. Those who did dust or spray usually covered their fields two or three times.

One application of dust or spray requires slightly less than 1 hour per acre in the Western Hilly, Delta, and Black Waxy Sections compared with 1.7 to 2.5 hours in the eastern sections. However, because a minority of farmers follow the practice, the average volume of labor actually used for this operation is small.

amounting to less than 1 hour per acre in all sections in 1936. With increasing numbers of farmers dusting and spraying, the trend in labor used was upward from 1909 to 1929 in spite of some increase in productivity in application. With lower cotton prices after 1929, less time was spent on this operation, and many farmers abandoned it entirely.

HARVESTING

Method and Times Over

Cotton picking constitutes the greatest labor load in the production of this crop. It is a tedious hand operation and lasts intermittently from 2 to 3 months in the fall. The need for keeping enough persons around the farm so that sufficient help will be available in the picking season has been an important influence in delaying adoption of larger equipment in the pre-harvest operations. Development of a satisfactory mechanical cotton picker would greatly affect other operations as well as cotton picking in sections where such a machine could be used.¹⁶



Bureau of Agricultural Economics, U.S.D.A.

FIGURE 15.— PICKING COTTON BY HAND IN NORTH CAROLINA

¹⁶See R. L. Horne and E. O. McKibben, *Changes in Farm Power and Equipment: Mechanical Cotton Picker* (WPA National Research Project, Report No. A-2, Aug. 1937).

A large amount of experimental work has been done in an effort to develop a mechanical cotton picker, and considerable progress seems to have been made. There are still some important mechanical as well as economic difficulties to overcome before such a machine is likely to be in wide use. An improved two-row machine, however, would probably find considerable application in sections where cotton is raised in relatively large fields and on land which is not too rough. These include the Mississippi Delta and the Texas Black Waxy Sections and other smaller areas where large farms or plantations prevail. Such a machine is not likely to be used in the Western Semiarid Section where many bolls do not open sufficiently for the lint to be extracted by the mechanical devices developed so far.



Anderson, Clayton, and Co.

FIGURE 16.— A 2-ROW COTTON PICKER

It has been estimated that an improved machine of this size would do the work of about 40 hand pickers.

Table 18.- LABOR REQUIRED IN HARVESTING, 1909-36^a

Section	Year	Number of times picked	Lint yield per acre ^b (pounds)	Lint picked per worker per day (pounds)	Hours required per acre		
					Total	Pick- ing	Haul- ing to gin
Coastal Plain	1909	3.2	231	45.6	53.9	50.7	3.2
	1919	3.2	209	46.3	47.7	45.1	2.6
	1929	3.1	196	46.9	44.3	41.8	2.5
	1936	3.1	239	47.0	53.5	50.8	2.7
Piedmont	1909	3.1	210	45.5	49.1	46.2	2.9
	1919	3.2	143	46.5	32.7	30.8	1.9
	1929	3.0	170	47.7	37.9	35.6	2.3
	1936	2.9	209	46.5	45.7	43.1	2.6
Eastern Hilly	1909	3.0	245	53.4	48.4	45.9	2.5
	1919	2.9	225	55.6	42.8	40.5	2.3
	1929	3.1	299	59.4	53.0	50.3	2.7
	1936	3.0	321	59.8	56.3	53.7	2.6
Western Hilly	1909	2.7	174	46.5	38.1	35.9	2.2
	1919	2.7	159	51.4	32.9	30.9	2.0
	1929	2.6	154	54.5	29.8	28.3	1.5
	1936	2.5	138	54.9	26.5	25.1	1.4
Mississippi Delta	1909	2.9	224	45.5	51.5	49.2	2.3
	1919	2.9	227	45.5	52.0	49.9	2.1
	1929	2.8	252	45.2	57.6	55.8	1.8
	1936	2.6	302	45.2	66.7	66.8	1.9
Texas Black Waxy	1909	3.0	199	75.2	28.4	26.5	1.9
	1919	3.0	172	76.8	23.4	21.8	1.6
	1929	3.1	177	74.4	25.0	23.8	1.2
	1936	3.0	170	60.0	22.3	21.2	1.1
Western Semiarid	1909	3.1	127	63.6	21.4	20.0	1.4
	1919 ^c	2.4	163	102.5	17.9	15.9	2.0
	1929 ^c	2.4	142	112.2	13.9	12.7	1.2
	1936 ^c	2.4	176	126.5	14.9	13.7	1.2

^aData obtained in NRP Farm Survey, 1936.

^bAverages for each section are averages of county yields weighted by the number of schedules obtained in each county (table A-4). For source and method of estimating yield, see p. 52, fn. 19.

^cIncludes picking and snapping (snapping predominating in 1929 and 1936).

At present, cotton is harvested by hand picking in all sections except the Western Semiarid, where picking, sledding, and snapping are done. Snapping cotton is the practice of pulling bolls, burr and all, from the stalk. The equipment for picking or snapping cotton usually is a sack approximately 28 inches wide and varying in length from 3 to 12 feet. The sack is dragged on the ground, supported by a wide strap over the shoulder which causes the sack to hang in a loop at one side of the picker. After it is picked or snapped, the cotton is usually weighed and emptied into a wagon, truck, or trailer equipped for hauling it direct to the gin.

Climatic conditions determine the rapidity with which bolls open and, therefore, the length of the picking period and the number of times a cottonfield will be picked. However, the earlier dates of planting of improved varieties have brought about an earlier harvest, a shorter harvest period, and a slightly reduced number of pickings in recent years, as indicated in table 18.

Cotton was picked an average of about three times in all sections studied. Where both snapping and picking were done, the average number of times was less than three, and where all cotton was snapped, two times over were sufficient.

The average number of pounds of seed cotton picked per worker per day is governed largely by the yield per acre and the number of times picked. The average number of pounds of seed cotton picked per day ranged from approximately 210 in the Western Semiarid to 134 in the Piedmont Section. In the Western Semiarid Section, where snapping is done, the average is approximately 500 pounds (including seed and burrs) per day. Lint cotton picked per worker per day ranges from 80 pounds in the Texas Black Waxy Section to about 45 pounds in the Mississippi Delta, while snapped cotton averaged about 130 pounds of lint per day in the Western Semiarid Section. Improved varieties of cotton which produce a higher proportion of lint per pound of seed cotton have increased the pounds per worker per day.

In the Western Semiarid Section climatic conditions and improved gin equipment (cleaners, extractors, driers) have made possible the almost complete abandonment of picking and the substitution of snapping, which requires much less labor than picking.¹⁷ The snapping is frequently performed by transient labor.

¹⁷C. A. Bonnen and A. C. Magee, *Farm Business Report, High Plains Cotton Area 1932* (Texas Agr. Expt. Sta. prelim. mimeo. report, Sept. 1933), p. 12.

The quality of lint obtained from snapped cotton is lower than that from picked cotton. The difference amounts to about one grade if the cotton is snapped when it first opens; if harvesting is delayed unduly, however, more serious losses may result from weathering.¹⁸

Since 1909 about 10 percent of the farmers in the Coastal Plain and Mississippi Delta Sections have shifted from the team and wagon to the truck for hauling seed cotton to the gin. This shift has resulted in a saving of about 15 percent in labor. In the Western Semiarid and Texas Black Waxy Sections the shift from the wagon to the trailer and truck has apparently resulted in a saving of about one-third in labor.

Labor Used Per Acre in Harvesting Cotton

Because the amount of labor needed for harvesting is determined to such a large extent by the yield, the labor for harvesting as obtained in the NRP Farm Survey has been adjusted to a 5-year average yield for the counties studied.¹⁹ The resulting estimates are shown in table 18.

In 1936 the estimated amount of labor used per acre for harvesting picked cotton ranged from 22.3 hours in the Texas Black Waxy Section to 68.7 hours in the Mississippi Delta. Since 1909 almost no reduction is shown in the Coastal Plain Section and only 3.4 hours in the Piedmont Section. Greater reductions are shown in the Western Hilly and Texas Black Waxy Sections. These sections indicate 30 and 21 percent decreases respectively, largely because of low yields in the recent years and an increase in the picking

¹⁸Bryan Eagle, Bryan, Tex., Dec. 7, 1936.

¹⁹Average yields of lint per acre for counties studied are estimated on the basis of census data and annual reports of the Bureau of the Census, U. S. Department of Commerce, on cotton ginned in the United States.

Acreage is not reported by counties for other than census years. Therefore, to obtain acreage harvested in the counties studied, 5-year averages centered on 1909, 1919, and 1929 were calculated. The average of 1933-38 (using 1934 as the base) was used to represent 1936. The following procedure was used: (1) A 5-year average acreage harvested for the State was calculated; (2) the relationship of the county acreage and the State acreage in the census year was determined; (3) the county average acreage harvested for the 5-year period was estimated on the basis of the relationship between the county and the State acreages in the census year.

Production likewise is reported only in the census years. However, the number of bales (500-pound gross weight) of cotton ginned in each county is reported annually by the Bureau of the Census, U. S. Department of Commerce. The 5-year average production for the county was estimated by determining the relationship of production to ginning figures in each county in the census period and then applying this relationship to average 5-year ginnings for the county.

The average yield of lint per acre was calculated from the average acreage and production so determined.



Bureau of Agricultural Economics, U.S.D.A.

FIGURE 17.— HOME-MADE SLED USED IN HARVESTING COTTON IN THE WESTERN SEMIARID SECTION

rate perworker. The more rapid picking has been achieved largely by less careful picking and involves collecting more trash along with the cotton.

The estimated amount of labor used per acre for harvesting in the Western Semi-arid Section was 14.9 hours in 1936 and 21.4 hours in 1909. This reduction was effected chiefly by the substitution of snapping for picking.

SUMMARY

It has been shown that the general process of cotton production has undergone but little change since 1909, but that there has been some decline in the amount of labor used on several of the operations. A slight decline was shown in labor spent in cleaning ditches and terraces and in cutting stalks in most of the sections where these operations are performed. Labor in flatbreaking and in bedding the land has declined in most sections but especially in the western ones. The same is true of cultivating and of hoeing and chopping. The greatest declines in the labor used in these operations have occurred in the Delta, Black Waxy, and Western Semi-arid Sections, where there has been the most progress in mechanization, and, in fact, where conditions have been most favorable to adoption of larger equipment. In the Western Semi-arid Section the decline in labor used in producing the crop

up to harvest has amounted to one-third since 1909, in the Black Waxy to about 10 percent, and in the sections farther east to smaller amounts.

Labor spent in harvesting the crop has not changed much for the Cotton Belt as a whole, except that it has varied with the yield from year to year. In the Black Waxy Section there has apparently been some speeding up in the process of picking, but this was accompanied by less careful picking. In the Western Semiarid Section the substitution of snapping or sledding of cotton for picking has meant a large reduction in the labor per acre where these methods are used, but again this has been accompanied by a lowering in the quality of the cotton picked. In the Mississippi Delta the amount of labor used in harvesting has increased one-third and that in the Eastern Hilly Section by one-sixth; in the Western Hilly Section a decrease of nearly one-third has occurred. These changes were due largely to changes in the yield per acre.

We shall return to the question of total labor used per acre and to the changes in total amounts required for the entire cotton crop in section V.

SECTION III

MECHANIZATION IN THE PRODUCTION OF COTTON¹

The amount of labor used per acre in producing cotton and, therefore, the acreage one man or one family can care for varies among areas and localities. In the Piedmont, Coastal Plain, Eastern Hilly, Western Hilly, and Mississippi Delta Sections of the Cotton Belt one family usually raises 12 to 18 acres of cotton. In the High Plains Section of Texas one farmer using two-row equipment grows from 75 to 150 acres of cotton with little or no hired help prior to harvest; with four-row equipment the acreage may be almost doubled.² In these more highly mechanized sections cotton production has been increasing while in the eastern part of the Cotton Belt it has declined.

PROSPECTS FOR AND LIMITATIONS TO MECHANIZATION

Knowing that these differences exist, one might well question whether still greater mechanization may be expected in the western areas; whether the amount of labor used in the eastern sections might be reduced through greater mechanization and the use of larger implements; and, if these changes are feasible, at what rate they are likely to proceed and what the resulting effect upon the employment of agricultural labor would be.

Under present conditions it is not probable that any great saving of labor will be effected through mechanization of cotton production in the near future in the upper Piedmont, Coastal Plain, Eastern Hilly, or parts of the Western Hilly Sections of the Cotton Belt. Small farms and irregularly shaped fields prevail in these sections. The small farms mean the use of small units of power and the irregular fields make it difficult to use larger implements to advantage.

Scattered throughout these sections are farms which contain rather large acreages of fairly level land on which a considerable degree of mechanization will take place. Such farms, however, are

¹This section was prepared by William C. Holley.

²*The World Cotton Situation, Part II: Cotton Production in the United States** (U. S. Dept. Agr., Bur. Agr. Econ., prelim. mimeo. report, Feb. 1936), pp. 28-9.



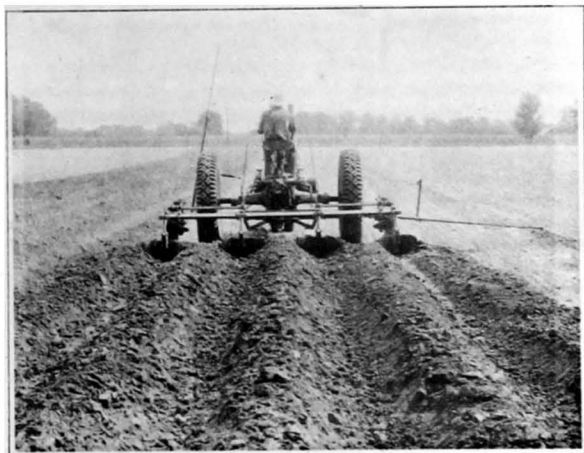
Bureau of Agricultural Economics, U.S.D.A.

FIGURE 18.— COTTON PATCH IN THE EASTERN COTTON AREA

Much of the crop is grown in small patches and on rough land. The possibilities of mechanization are limited here.

relatively few in number. Several factors tend to prevent more general mechanization and the use of large-scale equipment in these sections. The very sandy soils in the Coastal Plain Section, the small, irregularly shaped fields resulting from the wooded nature of the land, the hilly topography, and the numerous streams, together with the availability of large amounts of family labor which have little or no alternative employment, often make impossible the economical use of large equipment. Moreover, there are numerous farms on which the advantages and disadvantages arising from the adoption of larger equipment and more complete mechanization are approximately equal. On such farms inertia tends to discourage the shift.

However, in those sections which are not suited to the use of large-scale equipment, considerable saving in labor prior to harvest might be effected through the use of one-row equipment instead of the one-half-row equipment now being used in seedbed preparation and cultivation. Also, a considerable proportion of the labor of hoeing and chopping might be eliminated by the use of a hill-dropper planter.



Deere & Co.

FIGURE 19.—BEDDING UP FOUR ROWS AT A TIME

This tractor-drawn middlebuster represents a great increase in labor productivity over a 1-mule outfit.



International Harvester Co.

FIGURE 20.—ONE-RROW MIDDLEBUSTER DRAWN BY A LIGHT TRACTOR

This promises to save labor on cotton farms not big enough to afford the large unit shown in figure 19.

Conditions in the level to gently rolling Mississippi Delta and the Black Waxy Prairie and western sections of Texas are conducive to the use of large-scale, labor-saving machinery. Also, many of the farm units (that is, the entire plantations rather than the cropper units within plantations) in these sections are large enough to use such equipment economically. The adoption of larger-scale equipment has been increasing here in recent years. In the Mississippi Delta a considerable shift from the use of one-half-row to one-row equipment in seedbed preparation had taken place even prior to 1929.

INCREASED USE OF TRACTORS

The number of tractors has increased rapidly. In 1929 the census found tractors on only about 2 percent of the farms in the Eastern and the Delta Cotton States, on 6.4 percent of the farms in Texas, and on 11.4 percent of the farms in Oklahoma.³ The census, however, counts each cropper-holding as a farm, and many plantations consist of several cropper units. In the 1936 Farm Survey, in which the plantation was counted as the unit, the following percentages of farmers reported the use of tractors for the years indicated:

County and section	Percent of farmers reporting use of tractors		
	1919	1929	1936
Washington and Bolivar Counties, Miss. (Mississippi Delta)	5	32	45
3 western counties (Texas Black Waxy and Western Semiarid)	5	17	41
All other counties (2 in Western Hilly and 7 in eastern sections)	1	2	3

An appreciable proportion of the larger plantations reported the use of two or more tractors. This was true in 1929 of 6

³Fifteenth Census of the United States: 1930, "Agriculture" (U. S. Dept. Com., Bur. Census), vol. IV, chap. VII, table 19, p. 537.

percent of the farms studied in the Mississippi Delta Section and of 12 percent in 1936. In the Black Wax and Western Sections two or more tractors were reported by 2 percent of the farmers for 1929 and 4 percent for 1936. Indications are that the use of the tractor is continuing to increase, not only in the sections just discussed but also in other, though smaller, areas where conditions are favorable. The recent development by some of the farm-implement companies of smaller tractors, suited to use on relatively small farms, is likely to give further impetus to this movement. The smaller tractors, however, are likely to displace less labor per tractor than did the larger ones, which were adopted on the larger farms and generally under the most favorable conditions.

Along with the adoption of tractors has come an increase in the use of multirow equipment for seedbed preparation, planting, and cultivating. This has resulted in a decided saving of labor in preharvest operations. The adoption of the hill-dropper planter, particularly if it is of the multiple-row type, together with improved seed and methods of seed treatment, will eliminate a large amount of hand labor in chopping and hoeing. Some work is also being done in the development of mechanical means to perform the chopping operation, but this is still in the early stage of development.

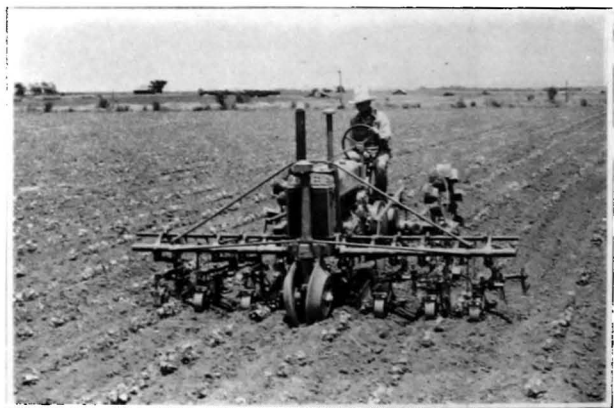
Although an increase in the number of farmers using hill-dropper planters and multiple-row equipment may be expected, the rate of adoption in the Mississippi Delta Section may be retarded by the fact that large amounts of labor are needed for picking, and in many cases it may be economically advantageous to insure an adequate supply of harvest labor by employing the laborers throughout the year. However, the increase in mechanization of preharvest operations in the Mississippi Delta has already resulted in some displacement of sharecroppers and share tenants.

It is becoming evident that the need for a supply of labor for picking is not an insuperable obstacle to mechanization of the preharvest operations. In western Texas and Oklahoma scarcity of rainfall limits weed growth; this factor combined with the level topography of the land makes it possible for a farmer and his family, even without tractor power, to grow much more cotton than they can harvest. Natural and economic conditions have also been conducive to the adoption of large-scale methods, and as a result a transient labor supply has been built up for the picking



International Harvester Co.

FIGURE 21.— PLANTING COTTON AND PUTTING DOWN FERTILIZER
IN ONE OPERATION



Deere & Co.

FIGURE 22.— FOUR-ROW TRACTOR CULTIVATOR
This unit does the work of at least eight men with 1-mule cultivators.

season. A recent study⁴ indicates that this labor pattern is pushing eastward into the Delta country. Tractors, multirow planters, and large tillage implements have already crowded many sharecroppers off the land and into the ranks of the seasonal laborers. In the absence of a successful mechanical picker this process will probably be slow, even in the Delta, for it will take several years to develop a supply of seasonal labor adequate to meet the needs of the picking season.

MECHANICAL COTTON PICKER

In the Black Waxy Prairie and the semiarid region of Texas it has been possible to secure transient laborers for much of the harvesting. A sufficient supply of labor for picking still remains a problem in these sections. The perfection of an efficient and economical mechanical cotton picker would to a large extent remove harvesting as an obstacle to mechanization in the Mississippi Delta and Texas Black Waxy Sections. Here the machine could be used extensively. The use of such a machine no doubt would facilitate a concerted rush toward the use of large-scale machinery for the preharvest operations and would thus result in a considerable displacement of agricultural workers. That such a development lies within the not-too-distant future seems probable. A large amount of work has been done on mechanical cotton pickers and certain machines seem to have approached practical usefulness.⁵

In the report on the *Mechanical Cotton Picker* it is said that:

Even though a mechanically successful and economically feasible cotton picker may be near at hand, its spread will probably be gradual rather than sudden. This view is strengthened by the history of the introduction of other agricultural machines. Rapid mechanization has occurred only where the financial rewards have been high or labor shortage acute. Therefore, as long as there is an abundance of cotton pickers willing to pick cotton for 75 cents to 1 dollar per 100 pounds, and as long as other prices maintain their present alignment, the mechanical picker cannot be expected to take the Cotton Belt by storm. A repetition of the conditions

⁴Paul S. Taylor, "Power Farming and Labor Displacement in the Cotton Belt, 1937," *Monthly Labor Review*, 48, No. 3 (Mar. 1938), pp. 596-607, and "Power Farming and Labor Displacement," *Monthly Labor Review*, 46, No. 4 (Apr. 1938), pp. 852-67.

⁵For a more complete discussion of the prospects for such a machine see R. L. Horne and E. O. McKibben, *Changes in Farm Power and Equipment: Mechanical Cotton Picker* (Works Progress Administration, National Research Project, Report No. A-2, Aug. 1937).

that existed toward the close of the World War, however, might be expected greatly to speed up the mechanical picker's adoption.⁶

If, in the course of 5 to 10 years, a successful two-row picker operated by one man should appear, it might be applied on as much as half of the normal cotton crop, or about 17½ million acres. This seems likely to be the upper limit, unless cotton production should be materially increased on new lands where conditions are favorable to mechanization. Savings in labor from the use of a machine on this proportion of the acreage might amount to approximately 800 million man-hours. This would be equal to the labor of 2 million hand pickers each working forty 10-hour days during the picking season.

The report just mentioned continues:

Widespread use of a mechanical picker would necessarily set in motion a chain of causes and effects which would reach beyond the cottonfields. The shift from animal to tractor power would not only result in a decrease in the labor required to raise and care for work stock, but would also result in a decrease in the labor required to grow feed both in the South and the Middle West, from which much feed is imported. Set against these decreases in labor requirements resulting from further mechanization of cotton would be the additional labor required to produce and distribute pickers, tractors, and tractor fuels and lubricants.⁷

Conditions in the Western Semiarid Section are more conducive to the use of large-scale machinery than are those in the other sections studied. The topography is relatively level and fields are large. The rainfall is relatively low and therefore weed growth following planting, particularly if the land is well prepared, is retarded, thereby eliminating much of the hoe work. As most of the bolls ripen about the same time and as snapping rather than picking is practiced, most of the cotton is harvested at the first picking. Under these conditions the use of transient labor for harvesting seems to have worked satisfactorily and to have removed the deterrent effect of a harvesting labor-requirement peak on the mechanization of the preharvest operations.

The use of tractors in conjunction with large-scale machinery has made rapid advances in the Western Semiarid Section. Tractor equipment is mostly of the two-row size but there is a definite

⁶Ibid., p. 18.

⁷Ibid., p. 19.

trend toward still larger units. A farm-management study in the High Plains Area of Texas, as reported in part II of *The World Cotton Situation*,⁸ shows that in 1930 tractors with two-row equipment were used on 31 of 140 farms studied and that by 1935, 8 of these farms had shifted to four-row tractor equipment.

In this area the use of two-row tractor equipment instead of horsepower would result in a saving of approximately 1 to 2 hours of man labor per acre in operations preceding harvesting. The use of four-row equipment would make possible the production of an acre of cotton with but 4 to 5 hours of man labor prior to harvest.⁹

Because of differences in climatic conditions and in growth characteristics of the cotton plant, a mechanical cotton picker which would be satisfactory in the eastern areas is not likely to be suited for use in the semiarid sections. The Texas Agricultural Experiment Station, however, has developed a mechanical harvester of the stripper type for use in the western areas which, experimentally, has shown promising results.

The further development of the mechanical cotton picker and of mechanical means of performing some of the cotton chopping, or at least of reducing the amount of hand work by better cultivation, would undoubtedly add fresh impetus to mechanization. Such developments would in all probability lead to larger relative acreages of cotton in the Mississippi Delta and Black Waxy Sections and in some other smaller areas, as well as to a pronounced displacement of hired laborers and sharecroppers. At present, larger equipment is available for performing most of the operations of seedbed preparation, planting, and cultivation, but its wider adoption is held back by the need for keeping enough workers around the farms for hoeing and picking.

⁸*The World Cotton Situation*, loc. cit.

⁹*Ibid.*

SECTION IV

PRINCIPAL INFLUENCES ON COTTON YIELD AND STAPLE LENGTH¹

The effectiveness of the labor used in producing cotton depends on several groups of technological influences besides mechanization and those practices which were discussed in section II. Among these are: (1) development and dissemination of improved varieties of cotton; (2) improvement of quality or increase of staple length; (3) improvements in cultural practices, especially crop rotation and the use of fertilizer; and (4) the development of methods of combating diseases and pests which prey on the cotton plant.

Better varieties of cotton and heavier or more effective application of fertilizers usually bring heavier yields per acre. The increased yields may require more labor per acre, especially in the harvesting operation, but they have generally resulted in a reduction of labor per bale of cotton produced. Much the same thing may be said of the development of cotton varieties producing longer staple. Although there may be no more of this cotton produced per acre, it represents a greater production per hour of labor in the economic sense, since it serves to increase the dollar yield per hour of labor. The outbreaks of diseases or pests affecting the cotton crop seriously reduce production per hour of labor by forcing the abandonment of acreage already planted, by cutting the yield, or by requiring additional labor for pest control. The development of more effective methods for controlling the boll weevil or any one of the various diseases to which the cotton plant is subject may be as important a technological influence as a higher-yielding variety or a new and more effective farm implement.

IMPROVEMENT OF COTTON VARIETIES

The migration of the boll weevil from Mexico into Texas in 1892 and its subsequent spread to all important cotton-producing regions by 1920 led to a decided shift in the varieties of cotton

¹This section was prepared by Lloyd E. Arnold.

grown in most areas. In a relatively short time many excellent varieties of long-staple upland cotton and nearly all the better varieties of medium-staple were lost. These desirable varieties gave way to others which were of a short, inferior staple, but which gave fairly high yields and matured early enough to escape at least some of the ravages of the boll weevil. In most instances these early, rapid-fruited varieties came from the northern part of the Cotton Belt.

Some years were required to produce new varieties which combined satisfactory yield and staple length with the early maturity needed in the presence of the weevil. Improvement both in yield and in quality is greatly hampered by the inability or unwillingness of a large number of cotton growers to take advantage of the more desirable varieties adaptable to their soil and climatic conditions. Many growers, on the other hand, who have planted superior varieties of cotton have been discouraged by the commercial practice of indiscriminate buying in the local markets where quality of fiber was little considered.

More than 1200 different varieties or names of cotton have been listed as grown in the United States. Of these, about 400 were added in the decade 1923-32.² Many of the older varieties are renamed but are indistinguishable from the parent stock. This multiplicity of varietal names is further complicated in most communities by the mixing of cottonseed at gins,³ as well as by cross-pollination of cotton in mixed-variety communities.

Early Improved Varieties

Through the efforts of the United States Department of Agriculture, three outstanding varieties - Durango, Meade, and Acala - were placed in commercial production in the period 1908-16.⁴ During this period the growers responded favorably to the opportunity to secure pure seed. The supply of pure seed was not adequate to meet the demand, however, and as a result commercial agencies sold large quantities of mixed seed. Consequently the quality of fiber produced in the following years declined and soon these varieties, except for the variety Acala, became undesirable.

²C. B. Doyle, "Multiplicity of Varieties Handicaps Improvement in the American Cotton Crop," *Yearbook of Agriculture, 1933* (U. S. Dept. Agr., 1933), p. 107.

³W. W. Ballard and C. B. Doyle, *Cotton-Seed Mixing Increased by Modern Gin Equipment* (U. S. Dept. Agr. Dept. Circ. No. 205, 1922), pp. 3-12.

⁴O. F. Cook and A. Y. Willis, Jr., *Uniformity of Cotton Fiber Determined by Field Inspection* (U. S. Dept. Agr. Circ. No. 310, 1934), p. 2.

Following the distribution of these and several other improved strains of cotton, the United States Department of Agriculture made a canvass which indicated that most of them had lost their identity, and consequently they have never been reestablished. Instead of serving a progressively useful purpose, they apparently only added to the general mixture of seed stock.⁵

The system of "hog-round"⁶ buying of cotton in the local markets has tended to suppress any far-reaching beneficial effect both on yield and on quality of the crop that otherwise might have occurred from the production of improved varieties. This has resulted in the continued extensive planting of gin-run seed. A survey a few years ago indicated that in many sections 90 percent of the crop was still planted to this type of seed.⁷

In an effort to overcome this situation, cotton-yield contests have been conducted, crop-improvement associations have been organized, and more recently many one-variety communities have been established in a number of States. In addition, weekly reports on the grade and staple of the crop are made available to the public by the Bureau of Agricultural Economics. The benefits to be derived from most of these measures are dependent upon the degree to which the cotton grower actually takes advantage of them.

Standard and Improved Varieties

In 1936 the American Society of Agronomy and the agronomists of the Association of Southern Agricultural Workers selected 31 varieties of cotton which are now recognized as standard varieties. New strains of cotton introduced since 1930, if superior, are eligible for registration as improved varieties. Three new varieties - Deltapine, Ambassador, and Washington - have been registered as such.⁸ The number of varieties and so-called varieties in production should decline in the future if producers of cotton-seed distribute only cotton varieties of proven superiority.

From a survey conducted in 1935 by the United States Department of Agriculture, estimates were obtained regarding the extent to

⁵Ibid.

⁶This means that within wide limits the buyer pays no attention to quality of fiber.

⁷C. B. Doyle, "Cotton Standardization in One-Variety Communities Essential," *The Cotton and Cotton Oil Press*, XXXVIII, No. 13, (1937), 28.

⁸H. B. Brown, "Registration of Improved Cotton Varieties. I," *Journal of the American Society of Agronomy*, XXVIII, No. 12 (Dec. 1936), 1019-20.

which improved varieties were grown in several States in 1934. There is much difference of opinion as to which varieties are "improved." For example, Half and Half, a short-staple variety of which there are many strains, was reported as an improved variety from Georgia, Tennessee, Alabama, Arkansas, and Oklahoma. Texas reports 46 improved varieties, Arkansas 37, South Carolina 22, Georgia and Tennessee 18, Alabama 17, Louisiana and Oklahoma 10, Mississippi 9, North Carolina 8, California 6, Arizona 5, and New Mexico 2. The acreage reported as devoted to these improved varieties represents approximately 82 percent of the harvested crop for 1934, but only about 5 percent of the total acreage is devoted to improved varieties of unquestioned superiority.⁹

In the above survey, Georgia reported 4 percent of its acreage devoted to highly improved varieties and a total of 25 percent devoted to all improved varieties.¹⁰ However, a systematic survey conducted in Georgia in 1935 to determine the number of acres planted to each variety of cotton indicates that the 1935 Department of Agriculture study may underestimate the extent of improved-variety plantings. Analyzed on the basis of the 1934 crop data, this survey revealed that 35.7 percent of the acreage was devoted to highly improved varieties and a total of 77.5 percent was devoted to all improved varieties.¹¹

Table 19 shows that cotton growers change their varieties rather rapidly. Since 1928 there has been a decline in the Oklahoma cotton acreage occupied by Half and Half from 32 percent of the total to 11 percent in 1931 and 13 percent in 1934. The acreage of Rowden expanded from 3 percent in 1931 to 10 percent in 1934. The figure for 1934 is based on the acreage of Rowden 40, a variety with staple length of 1 to $1\frac{1}{4}$ inches.

The rapid shifting of varieties is even more forcibly illustrated in table 20. Half and Half and Cleveland represented 62 percent of the cotton planted in Louisiana in 1926. In 1934 these varieties were no longer reported as improved, but were included in the mixed varieties, all of which, combined, made up only 21 percent of all cotton in the State. On the other hand, improved varieties of D. and P. L., Delfos, Missdel, and Stoneville accounted for 79 percent of the cotton planted in Louisiana in 1934.

⁹J. O. Ware, *Extent of Improved Varieties of Cotton in the United States* (U. S. Dept. Agr. Leaflet, mimeo., 1937), p. 11.

¹⁰*Ibid.*, p. 3.

¹¹E. C. Westbrook, *A Survey of the Varieties of Cotton Grown in Georgia in 1935* (Ga. Agr. Ext. Service Bull. No. 456, 1936), pp. 10-17.

Table 19.- PERCENTAGE OF OKLAHOMA COTTON ACREAGE DEVOTED TO PREDOMINANT VARIETIES 1928-31 AND 1934^a

Variety	1928	1929	1930	1931	1934
Half and Half	32.2	31.6	23.0	10.6	13.0
Mebane	21.2	20.9	22.6	29.4	25.0 ^b
Acala	18.9	18.5	19.9	18.2	12.0
Oklahoma 44	8.0	8.4	10.4	8.1	15.0
Kasch	2.1	2.4	2.2	3.5	n. a.
Delfos	2.9	2.6	3.0	2.4	n. a.
Rowden	1.2	1.1	1.5	2.8	10.0 ^c
Russell	1.4	1.8	1.8	1.5	n. a.
Cleitt	0.5	0.8	1.2	2.8	n. a.
Qualla	0.6	0.7	1.0	2.1	n. a.
Miscellaneous ^d	11.0	11.2	13.4	18.6	25.0

^aData for 1928-31 from R. A. Ballinger and C. C. McWhorter, *Economic Aspects of the Trade and Staple Length of Cotton Produced in Oklahoma* (Okla. Agr. Expt. Sta. Bull. No. 212, 1933), pp. 33-4; 1934 from J. O. Ware, *Extent of Improved Varieties of Cotton in the United States* (U. S. Dept. Agr. Leaflet, mimeo., 1937), p. 9.

^bMebane Triumph strains, such as Qualla, Kasch, Cleitt, Ferguson 406, New Boykin, and Harper.

^cRowden 40.

^dVarieties of which small acreages were grown, and gin-run and run-out varieties.

n. a. Data not available.

Table 20.- ESTIMATED PERCENTAGE OF LOUISIANA COTTON ACREAGE DEVOTED TO SELECTED VARIETIES IN 1926^a AND 1934^b

1926		1934	
Variety	Percent of acreage	Variety	Percent of acreage
Half and Half	39.2	D. & P. L. 10	10.0
D. & P. L. 4	1.4	D. & P. L. 4-8	21.3
Cleveland	23.0	D. & P. L. 11	1.7
Delfos	13.8	Delfos 531, 555, and 2323	10.0
Mebane Triumph	1.2	Stoneville strains	16.7
Toole	1.1	Missdel 2	16.7
Other varieties	4.3	Missdel 3	2.5
Mixed varieties	15.9	Mixed varieties	21.2

^aPercentage of acreage grown in 47 parishes, as reported by county agents. H. B. Brown, *Cotton Varieties for Louisiana* (La. Agr. Expt. Sta. Bull. No. 207, 1930), p. 6.

^bJ. O. Ware, *Extent of Improved Varieties of Cotton in the United States* (U. S. Dept. Agr. Leaflet, mimeo., 1937), p. 8.

All of these improved varieties produce a cotton with staple 1 inch or more in length.

Varieties Reported by Growers in the NRP Farm Survey

A pronounced shifting of varieties was also reported by farmers interviewed in the 1936 Farm Survey.¹² There has occurred a steady increase in the percentage of farmers reporting several new varieties in the Eastern Area. Of these, D. and P. L. and Stoneville Farm Relief have shown notable gains in recent years. On the other hand, the percentage of farmers reporting Cleveland and Cleveland Big Boll has declined from 32 percent in 1909 to 8 percent in 1936. In the Delta Area such varieties as D. and P. L., Stoneville Farm Relief, Delfos, and Missdel have been reported with increasing frequency while Cleveland, Cleveland Big Boll, and Rowden are reported with less frequency in recent years.

In the Western Area the outstanding shift in varieties reported is the very large change in the percentage of growers reporting the variety Half and Half. In 1909 only 8 percent of the growers reported this variety, while in 1936 it was reported by 64 percent. While Half and Half increased in popularity, the variety Rowden declined from 24 percent to less than 1 percent. Likewise Mebane and Mebane strains declined nearly one-half.

Cotton Yield Contests and Demonstrations

In an effort to improve the staple length of cotton, as well as to prove to growers that cotton of a more desirable staple length could be grown at a profit to the farmer, a cotton-yield contest was inaugurated in South Carolina in 1926.¹³ In the period 1921-25 the average yield of lint in South Carolina was 181 pounds per acre; for 1928-32 it was 218 pounds; and for 1933-36, 261 pounds per acre.¹⁴ There have, of course, been other influences on the yield of cotton besides the cotton contest. However, it seems to have played an important part in fostering the idea that cotton production could be improved. Except in 1935, the State contest winner produced over 1000 pounds

¹²See table D-1.

¹³D. W. Watkins, *The Cotton Contest . . . 1926* (Clemson Agr. College Ext. Service Circ. No. 88, 1927), p. 3.

¹⁴*Cotton Revisions, Acreage, Yield and Production, Crop Years 1886-1935, by States* (U. S. Dept. Agr., Bur. Agr. Econ., Crop Reporting Board, mimeo., Nov. 1936), p. 8; *Agricultural Statistics, 1937* (U. S. Dept. Agr., 1937), p. 90.

of lint per acre, and in 1936 the winner produced 1,328 pounds of lint per acre with a staple of $1\frac{1}{2}$ inches.¹⁵

The effect of the cotton contest on length of staple produced by contestants is shown in table 21. In 1926, 41 percent of the lint produced on contest plots was $\frac{15}{16}$ inch or longer. The percentage of production of this length increased steadily until 1935, when 98 percent of the cotton produced in the contest was of this staple. In 1936 there occurred a slight decline in $\frac{15}{16}$ -inch and longer staple cotton. The cotton contest undoubtedly stimulated the shift to longer-staple varieties by the growers of the State as a whole. The production of $\frac{15}{16}$ -inch cotton and longer has increased from a low of 38 percent in 1928 to a high of 94 percent in 1936.

Table 21.- STAPLE LENGTH OF SOUTH CAROLINA COTTON
Percentage of Crop $\frac{15}{16}$ Inch or Longer as Produced by
Contestants and the State at Large and the
Average Staple Lengths of Contest Winners
1926-36

Year	Percent of crop $\frac{15}{16}$ inch or longer		Average staple length of contest winners ^c	
	Contestants ^a	State at large ^b	Sixteenths of an inch	Inches
1926	40.8	n. a.	15.4	0.962
1927	61.9	n. a.	16.2	1.012
1928	78.3	38.0	16.1	1.006
1929	79.8	35.9	16.0	1.000
1930	87.8	55.4	16.1	1.006
1931	94.8	59.7	16.4	1.025
1932	n. a.	74.5	n. a.	n. a.
1933	n. a.	82.5	n. a.	n. a.
1934	96.0	79.1	16.4	1.025
1935	98.1	80.7	16.0	1.000
1936	95.8	94.1	16.6	1.038

^aR. W. Hamilton and B. E. G. Prichard, *The Cotton Contest . . . 1936* (Clemson Agr. College Ext. Service Circ. No. 156, 1937), p. 9.

^b*Grade, Staple Length, and Feederability of Cotton in the United States, 1928-29 to 1933-34* (U. S. Dept. Agr. Statistical Bull. No. 52, 1936), pp. 18-20; same for 1928-29 to 1934-35 (Statistical Bull. No. 56, 1937), pp. 21-23; same for 1928-29 to 1936-37 (mimeo., 1937), p. 78.

^c*The Cotton Contest . . . 1926 to 1931, 1934 to 1936* (inclusive) (Clemson Agr. College). Staple length is customarily reported in sixteenths of an inch. For the benefit of readers not familiar with the customary measurement the averages are also given here in inches.

n. a. Data not available.

¹⁵R. W. Hamilton and B. E. G. Prichard, *The Cotton Contest . . . 1936* (Clemson Agr. College Ext. Service Circ. No. 156, 1937), p. 9.

Cotton demonstration plots grown by farmers in Arkansas over a 5-year period produced on the average 447 pounds more of seed cotton to the acre than did other fields of cotton grown in the immediate vicinity of the demonstrations. The maximum increase in yield occurred in 1932, when the demonstration plots exceeded the yield of local cotton by 907 pounds of seed cotton per acre.¹⁶

Similar demonstrations in Mississippi, Louisiana, and Georgia show a potential increase in yield of about 420, 465, and 380 pounds of seed cotton per acre respectively.¹⁷

One-Variety Communities

The purpose of the one-variety community is to make possible the production of a cotton uniform in quality and of desirable staple length. Communities of progressive farmers, properly organized, can eliminate the production of inferior cotton by confining their production to a single variety. Mixing of seed of different farmers almost invariably occurs at the gin, and it is possible to keep the seed stock pure only when all farmers in the community produce the same variety.

This plan was first suggested in 1909.¹⁸ In 1912 the first definite community project was started in the Salt River Valley, Arizona, with the production of the Yuma variety of Egyptian cotton. The possibilities of community production are amply demonstrated by the fact that in 1918 the growers in the Salt River Valley shifted their entire acreage from the production of the variety Yuma to that of an improved variety, Pima.¹⁹

Between 1912 and 1920 a few communities in the main Cotton Belt made an effort to produce cotton on the one-variety basis, but with little success. In the latter year, however, a one-variety community was organized in the Coachella Valley of California for production of the variety Acala.²⁰ In 1923 an ordinance was passed by Riverside County in California which defined and established pure-seed districts in the county and prohibited the

¹⁶ *Annual Report of Extension Service* (Ark. Ext. Circ.) as follows: (No. 287, 1929), p. 28; (No. 280, 1930), p. 25; (No. 292, 1932), p. 25; (No. 302, 1933), p. 25; (No. 329, 1934), p. 23.

¹⁷ *Annual Reports of Cooperative Extension Work for Years 1923 to 1933* (Miss. State College Ext. Dept.); *Annual Report of Extension Work for Years 1924 to 1930* (La. State University, Div. of Agr. Ext.); E. C. Westbrook, *Cotton for Georgia, 1932* (Ga. Ext. Circ. No. 211, 1933).

¹⁸ O. F. Cook, *Local Adjustments of Cotton Varieties* (U. S. Dept. Agr., Bur. Plant Industry Bull. 159, Sept. 28, 1909), p. 41.

¹⁹ *Ibid.*, pp. 894-7.

²⁰ H. T. McKeever, *Community Production of Acala Cotton in the Coachella Valley of California* (U. S. Dept. Agr. Dept. Bull. No. 1467, 1927), p. 1.

planting, transportation, or possession of impure seeds in such districts.²¹ This action by Riverside County was declared unconstitutional in 1924. In the following year, however, the State of California enacted a bill which protects one-variety communities.²²

The more recent interest in one-variety communities in the main Cotton Belt started in 1931 following a cooperative agreement the preceding year between the United States Department of Agriculture and the American Cotton Cooperative Association and affiliated State agencies to foster one-variety community organizations.²³ By 1932 approximately 75 one-variety communities were operating from North Carolina to Texas.²⁴ By 1936 more than 350 communities in 11 States of the main Cotton Belt, comprising nearly 1 million acres of planted cotton, were in various stages of development.²⁵ Since the release of these figures additional communities have been reported, and by the fall of 1937 the active number stood at upward of 500. It is estimated that these communities planted close to 2 million acres of selected varieties of cotton in 1937.²⁶

The growth of one-variety communities in Georgia is shown in table 22. In this State the number of such communities increased from 12 in 1933 to 138 in 1936. Likewise the number of growers participating has increased from 2,000 to 15,194. In 1936 a total of 217,206 acres was devoted to adapted varieties which produced an average acre-yield increase of 40 pounds of lint cotton.

The potential effect which one-variety communities may have on the staple length of cotton produced is well illustrated in table 23. In the Orchard Hill Community of Spalding County, Georgia, 81 percent of the cotton in 1928 was of a staple shorter than 1 inch, while by 1936 only 2 percent of the cotton produced in this community was of this length. There has also occurred an improvement in the quality of cotton produced in District No. 2, in which Orchard Hill Community is located. There are a number of other one-variety communities in District No. 2, as well as in the State at large.

²¹*Ibid.*, p. 26.

²²*Ibid.*, pp. 34-5.

²³C. F. Cook and C. B. Doyle, "One-Variety Community Plan Shows Numerous Practical Advantages," *Yearbook of Agriculture*, 1933 (U. S. Dept. Agr., 1933), p. 125.

²⁴*Ibid.*, p. 136.

²⁵C. B. Doyle, *op. cit.*, p. 28, insert B.

²⁶Unpublished data of the Cotton Division, Bureau of Plant Industry, U. S. Department of Agriculture.

Table 22.- COTTON PRODUCTION OF ONE-VARIETY COMMUNITIES IN GEORGIA, 1933-36^a

Number of -	1933	1934	1935	1936 ^b
One-variety community projects	12	55	118	138
Growers participating in projects	2,000	6,000	10,000	15,194
Acres in the adopted varieties	30,000	80,000	150,000	217,208
Bales produced of adopted varieties	20,000	43,500	75,000	103,921
Average pounds of lint per acre above yield of varieties grown nearby	50	50	40	40
Average premium (points) per pound received above price of other cotton	60	60	62	100

^aC. B. Doyle, "Cotton Standardization in One-Variety Communities Essential," *The Cotton and Cotton Oil Press*, XXXVIII, No. 13 (1937), 28, insert C.

^bUnpublished data of Cotton Division, Bureau of Plant Industry, U. S. Department of Agriculture.

Table 23.- AVERAGE STAPLE LENGTH OF UPLAND COTTON PRODUCED IN SPECIFIED REGIONS OF GEORGIA AND IN THE ENTIRE STATE, 1928-36^a

Year	Orchard Hill, Spalding County		District No. 2		Georgia	
	Sixteenths of an inch	Inches ^b	Sixteenths of an inch	Inches ^b	Sixteenths of an inch	Inches ^b
1928	15.29	0.958	14.74	0.921	14.58	0.912
1930	14.77	0.923	14.70	0.919	14.55	.909
1933	16.35	1.022	14.88	0.930	14.62	.926
1934	16.65	1.053	15.47	0.967	15.13	.946
1935	16.40	1.025	15.52	0.970	15.18	.949
1936	16.63	1.039	16.06	1.004	15.42	.964

^aGrade, Staple Length, and Fenderability of Cotton in the United States, 1928-29 to 1933-34 (U. S. Dept. Agr. Statistical Bull. No. 52, 1936), p. 21; same for 1928-29 to 1934-35 (Statistical Bull. No. 56, 1937), p. 24; same for 1928-29 to 1935-36 (Statistical Bull. No. 60, July 1937), p. 20; same for 1928-29 to 1936-37 (mimeo., 1937), p. 24; N. H. Penny, U. S. Department of Agriculture, Bureau of Agricultural Economics, Experiment, Georgia, in correspondence with the author, July 12, 1937; F. H. Harper, U. S. Department of Agriculture, Bureau of Agricultural Economics, Washington, D. C., in correspondence with the author, July 2, 1937.

^bStaple length is customarily reported in sixteenths of an inch. For the benefit of readers not familiar with the customary measurement the averages are also given here in inches.

For the years represented in table 23, the average staple length of cotton produced in the Orchard Hill Community, in District No. 2, and in the State of Georgia as a whole has ranged from 0.923 to 1.053 inches, from 0.919 inch to 1.004 inches, and from 0.909 inch to 0.964 inch respectively. It is interesting to note that the staple of cotton in the one-variety community, as well as that of District No. 2, is well above that for the State as a whole.

One community in the black lands of Texas reports an increased production of 26 pounds of lint cotton per acre on 2,600 acres. In addition to increased yield, the premiums for one-variety cotton here and in the other States in 1936 ranged from 100 to 185 points, or from 1 to about 2 cents a pound.²⁷

A cotton-classing bill has recently been enacted which would provide classification service to any group of producers organized to promote the improvement of cotton, provided they abide by certain regulations.²⁸ Such an arrangement should be very helpful to growers in obtaining premiums for cotton of the higher qualities. It has been claimed that within 5 years 80 percent of the Cotton Belt could be organized on the one-variety-community basis if concerted and intensive effort were put forth.²⁹

Maintaining Seed Stocks in One-Variety Communities.— Once a one-variety community is developed, there arises the need for the production of a suitable seed stock each year. Selection is the approved means of keeping a variety uniform. The method of selection must be such as to maintain production. In the past, cotton growers were led to believe that selection at intervals of several years was sufficient and that after a few generations it was only natural that varieties would "run out." Experience has shown, however, that by constant selection varieties of cotton can be grown for long periods.³⁰ An effective method of maintaining all the desirable features of a cotton variety is by type selection.³¹

²⁷C. B. Doyle, *op. cit.*, p. 28, insert C.

²⁸E. D. Smith, "The New Cotton Classing Bill," *American Ginner and Cotton Oil Miller*, XIV, No. 8 (1937), pp. 4-5.

²⁹*Ibid.*

³⁰O. F. Cook, *Cotton Improvement through Type Selection* (U. S. Dept. Agr. Tech. Bull. No. 302, 1932), p. 17.

³¹*Type selection is a process in which the choice of individuals to furnish seed for progeny plantings is limited to a single type of plant so that the progeny blocks are made as uniform as possible to the limit of the breeder's ability to avoid deviations from the type. Also any variant individuals that can be detected are removed from progeny blocks and increase fields as a means of maintaining the uniformity of the stock.* *Ibid.*, p. 14.

A one-variety community may be organized either as a pure-seed community or as a production community. In the latter instance the seed is secured from other communities or from responsible and qualified commercial seed breeders and is then increased by selected growers for community planting. In the pure-seed communities the breeding and selection work to maintain purity may be a regular part of the program.³² In California communities, parent seed is maintained by type selection. This parent seed is furnished to a select group of growers for increase, where it is rogued to eliminate off-type plants. The seed from these increase fields is known as registered seed. The following year this seed is further increased for general distribution. This is known as certified seed.³³ As a rule, 3 or more years are required to take seed from the breeder and increase it to a point where sufficient seed will be available for the entire community. The length of time required to produce planting seed will depend entirely upon the organization in each community. The "increase" method of seed production from foundation stock provides a one-variety community with a dependable supply of seed each year, and should tests demonstrate the need for a change in variety, this could be accomplished in the course of 3 years, with no mixing of varieties.

Improvement Achieved in Upland Cotton

How much improvement has actually been accomplished in length of staple and market tenderability of cotton by the dissemination of improved varieties, cotton contests, development of one-variety communities, and so on? Comparable data on the quality of cotton produced in the United States are not available for crops prior to that of 1928, when the Division of Cotton Marketing, Bureau of Agricultural Economics, by authority of legislation enacted in 1927 (Act of March 3, 44 Stat. 1372-1374), began issuing reports on the basis of the classification of samples gathered from all over the Cotton Belt.

Since 1928 considerable improvement has taken place in staple length of the domestic crop. For the Eastern Cotton Area the average annual staple length of the crop has increased from 0.915

³²Cook and Doyle, *op. cit.*, p. 137

³³J. E. Bite, *Community Production and Distribution of Cotton Planting Seed in a One-Variety Cotton Community* (U. S. Dept. Agr. Circ. No. 286, 1933), p. 4.

inch in 1928 to 0.968 inch in 1936. The staple length of cotton from this area is somewhat below the average staple length for the entire domestic crop. On the other hand, cotton produced in the Delta Area has an average staple much above the average of the United States crop. The staple of Delta cotton has increased from 0.997 inch in 1928 to 1.035 inches in 1936. The staple length of cotton produced in the Western Area has fluctuated from year to year, but on the whole has tended to decline, perhaps largely because of weather conditions. In 1928 the average staple was 0.938 inch; it reached a high of 0.949 inch in 1933 and then declined to 0.922 in 1936. The staple length of cotton from the Western Area has remained below the average for the United States. The average for the domestic crop has increased from 0.949 inch in 1928 to 0.986 inch in 1936, as shown in figure 23.

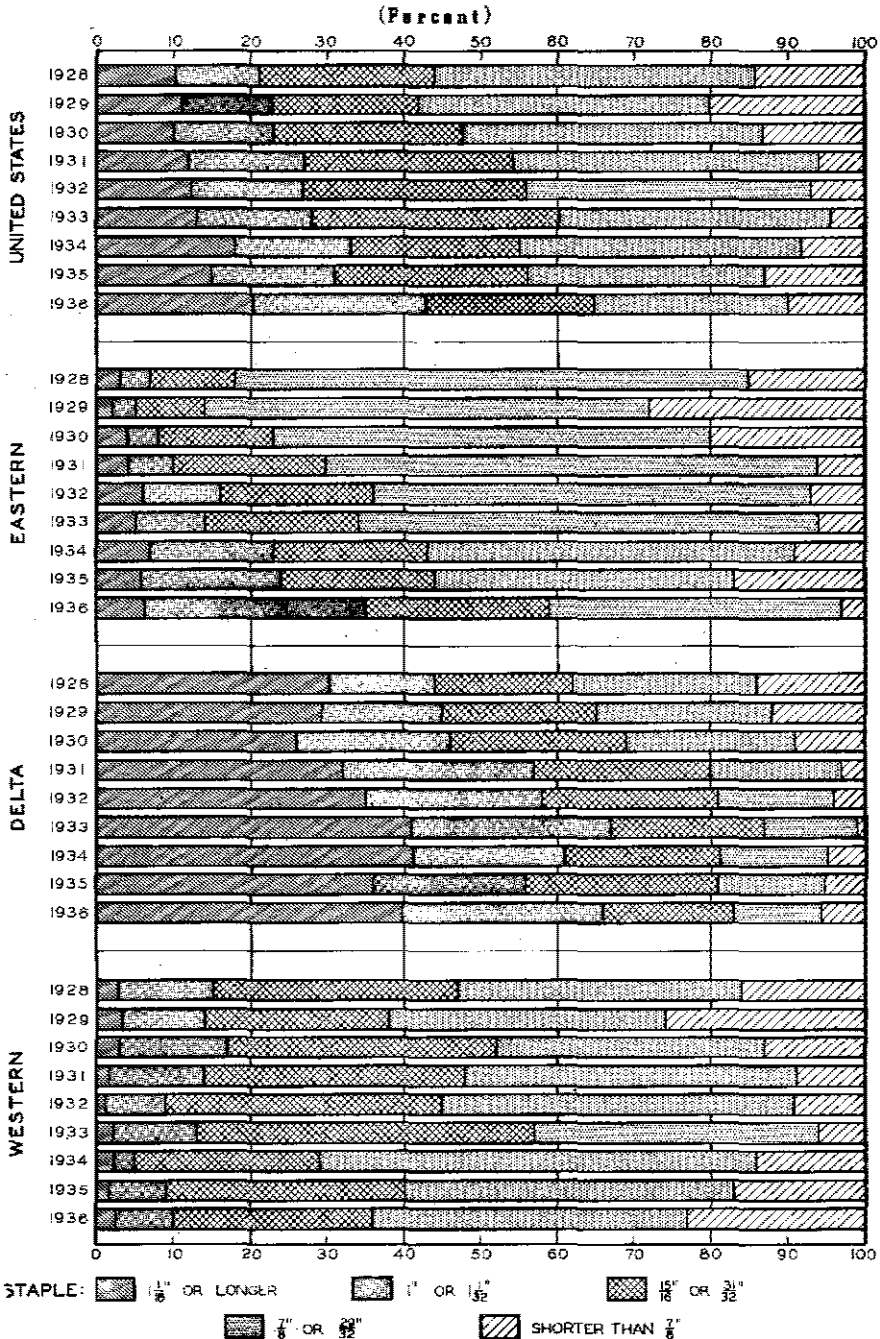
The upward trend in average staple length of the crop during the last 9 years has resulted in a decrease in the percentage of the crop falling in the shorter staple lengths and a proportionate increase in the more desirable staple cotton, as shown in figure 23. Cotton with staple 1 inch or longer in the Eastern Area increased from 7 percent in 1928 to 35 percent in 1936 and when $\frac{3}{4}$ -inch (0.938) cotton is included, the shift was from 18 to 59 percent. In both 1928 and 1936 cotton with staple 1 inch or longer included a much greater percentage of the production of the Delta Area than of either the Eastern or Western Area. Cotton 1 inch and longer in the Delta Area in 1928 accounted for 44 percent of the production, and by 1936, 66 percent.

The average production of various staple lengths for the United States for the period 1928-36 shows a decided increase in the percentage of cotton $1\frac{1}{4}$ (1.062) inches and longer, as well as in the percentage of cotton of the lengths 1 inch and $1\frac{1}{2}$ (1.031) inches. This shift has been from 10 to 20 percent and from 11 to 23 percent respectively.

Tenderability of Upland Cotton.- The proportion of tenderable cotton³⁴ has increased in the United States, particularly in the Eastern and Delta Areas, since 1928. The tenderability of cotton, since it is determined by staple length and grade, is influenced by weather conditions throughout the growing and harvesting seasons.

³⁴Tenderable cotton is that recognized as acceptable in discharging contracts for future delivery. Untenderable cotton includes cotton shorter than $\frac{3}{4}$ inch in staple, regardless of grade, and cotton of certain of the lower grades in the various color groups irrespective of staple length.

Figure 23.- PERCENTAGE DISTRIBUTION BY STAPLE LENGTH OF COTTON PRODUCED IN THE UNITED STATES AND IN MAJOR AREAS, 1928-36



Based on *Grade, Staple Length, and Fecundability of Cotton in the United States, 1928-29 to 1933-34* (U. S. Dept. Agr. Statistical Bull. No. 52, 1935), pp. 17-20; and same for 1928-29 to 1935-37 (mimeo., 1937), pp. 22-3

#PA - National Research Project

RECENT DEVELOPMENTS IN CULTURAL PRACTICES

The principal experimental developments in cultural practices affecting cotton production may be grouped under:

- (1) Changes in rotations and cropping practices.
- (2) Changes in the amounts and types of fertilizer applied.
- (3) Changes in the method of planting, particularly with regard to spacing of rows and of plants in the row.
- (4) Change in the objective sought in cultivation.

The last two have already been discussed in section II, where the data on experimental developments were supplemented by information from the NRP Farm Survey and other sources. Changes in the rotations advised by experimental workers, their significance to yields, and changes in the use of fertilizers will be taken up below.

Crop Rotation

There are, of course, many variations of cropping systems. The important objectives of any system of rotation are (1) high crop yields, (2) weed control, (3) maintenance of organic matter and regulation of use of plant nutrients, (4) control of insects and diseases, and (5) securing an even seasonal distribution of labor requirements.

Throughout the Cotton Belt, except in the High Plains sections of Texas and Oklahoma, there is continual need for additional organic matter other than that supplied by the cash or feed crop. A failure to furnish this organic matter reduces the efficiency of any commercial fertilizer which may be applied to the soils. The ability of the cotton plant to obtain plant food and moisture from the soil and also to utilize profitably the nutrients in fertilizer is determined largely by the physical condition of the soil and the solvent power of the soil water. Decaying vegetable matter assists greatly in this process and this is the fundamental reason for the increasing emphasis on the use of green manure in the Cotton Belt. There are many crops suitable for this purpose, both legume and nonlegume. Among the legumes which are used are vetch, cowpeas, soybeans, crimson clover, sweet clover, bur clover, and velvet beans. The nonlegumes include the small grains and millet.

Extensive experimental data are available which point to the value of green manure in the production of cotton.³⁵ When leguminous green manures are used, the nitrogen returned to the soil is sufficient for crop production and eliminates the need of purchasing this plant-food element in the form of commercial fertilizer. The increased yield of cotton which may be expected from the use of a green manure crop depends largely upon the kind used and the natural fertility and physical structure of the soil. Increased yields of seed cotton, varying from about 20 percent to over 200 percent, have been obtained.³⁶

Farmers have not always considered it desirable to plow under green manure crops.³⁷ Their acceptance of the practice has been caused largely by the realization that it is not necessary to buy nearly so much nitrogenous fertilizer when a leguminous green manure crop is used. It was pointed out as early as 1902 in Alabama that the most promising method of increasing the yield of cotton and the profits thereof is by a more general use of leguminous crops as fertilizers.³⁸

The experimental results summarized in table 24 show that the increase in yield that occurs when a green manure crop is plowed under is generally larger than the additional increase secured by applying nitrogen when a green manure crop is also used.

In 1929, winter legumes in the Cotton Belt were grown for green manure on an estimated 250,000 acres and in 1935 on about 350,000 acres.³⁹ The total acreage planted to green manure crops greatly exceeds this figure since rye is seeded on a considerable acreage each year.

Very little labor is required to produce a green manure crop following cotton. The seed may be sown broadcast or with a drill

³⁵*Effects of Winter Soil-Conserving Crops* (U. S. Dept. Agr., Agricultural Adjustment Administration, Special Report on Agricultural Conservation - 2, 1936), p. 54; *Effects of Summer Soil-Conserving Crops on Yields of Other Crops* (U. S. Dept. Agr., Agricultural Adjustment Administration, Special Report on Agricultural Conservation - 1, 1936), p. 64.

³⁶*Ibid.*

³⁷It may be truly said that the practice of turning under a crop of cowpea vines - ready for the mower and in a few days for the barn and for cattle - has no more reason to sustain it than would the practice of turning under a crop of wheat, oats, corn, or cotton at its most vigorous stage of growth. Nearly every form of stock food would be a valuable and effective fertilizer if applied immediately and directly to the soil; but the farmer, in an economic sense, can no more afford to manure his soil with a crop of pea vines that are ready to mow than he can to sow good, sound wheat bran on his land as a fertilizer.* R. J. Redding, *Fertilizer, Culture and Variety Experiments on Corn, I, Fertilizer and Variety Tests on Cotton, II, Green Manuring with Cow Peas, III* (Ga. Expt. Sta. Bull. No. 27, Dec. 1894), p. 209.

³⁸J. F. Dugger, *The Cowpea and the Velvet Bean as Fertilizers* (Ala. Agr. Expt. Sta. Bull. No. 120, 1902), p. 176.

³⁹Roland McKee and A. D. McNeil, *Winter Legumes for Green Manure in the Cotton Belt* (U. S. Dept. Agr. Farmers' Bull. No. 1663, rev. 1936), p. 2.

Table 24.- EFFECT ON SEED-COTTON YIELD OF TURNING UNDER GREEN MANURE COVER CROP WITH AND WITHOUT AN APPLICATION OF NITROGEN

(Average for 1926-35 in Georgia^a and for 1929-32 in South Carolina^b)

Green manure crop used	Average yield of seed cotton per acre in pounds			
	Georgia		South Carolina	
	Without nitrogen	With nitrogen	Without nitrogen	With nitrogen
None	735	973	1,505	1,654
Austrian winter peas	1,272	1,240	1,604	1,738
Monantha vetch	1,169	1,380	1,735	1,829
Hairy vetch	1,138	1,327	1,778	1,859
Rye	1,026	1,249	n. a.	n. a.

^aSixteenth Annual Report, 1935-1936 (Ga. Coastal Plain Expt. Sta. Bull. No. 26, 1936), p. 36.

^bE. E. Hall, W. B. Albert, and S. J. Watson, *Winter Cover Crop Experiments at the Pee Dee Experiment Station* (S. C. Agr. Expt. Sta. Circ. No. 51, 1933), p. 13.

n. a.-Data not available.

in cotton middles. If broadcast, the seed may be covered either with a one-horse plow or cultivator or with a two-horse cultivator that straddles the row. If drilled, a 3-foot, one-horse drill serves the purpose and no additional labor is required. The labor involved, therefore, would approximate that required to cultivate cotton once, plus - when broadcast - the time required for this operation.

In addition to winter legumes for soil improvement, large acreages of summer legumes interplanted with row crops, especially corn, are grown throughout much of the Cotton Belt. In many areas the practice of interplanting corn with a legume is almost universal. This is particularly true in Georgia, where it is estimated that about one-third of the entire corn acreage of the State was interplanted with legumes in 1936.⁴⁰ A recent experiment conducted in Louisiana indicates that the yield of cotton may be increased by better than 40 percent where soybeans are interplanted with the corn that preceded the cotton. The yield of corn under such a practice was reduced by about 10 percent.⁴¹

⁴⁰Some 1936 Improvements on Georgia Farms, *Annual Report of Agricultural Extension, 1936*, (1937), p. 12.

⁴¹C. E. Haddon, *Biennial Report of the Northeast Louisiana Experiment Station*, (St. Joseph, La., 1935-36), p. 6.

Fertilizer

The use of the proper fertilizer is very important in the production of cotton, both from the standpoint of total yield and relative to the amount of cotton secured at the first picking. Changes in farm practices in the application of fertilizer have already been discussed in section II. Here we shall discuss briefly the results of recent experiment-station investigations in use of fertilizer and changes in its content of plant food. The amounts of nitrogen, phosphorus, and potash materially influence the yield at the first picking, as well as the total production, as indicated in the following summary of an experiment:⁴²

Treatment	Pounds of seed cotton produced per acre	
	First picking	Total
No fertilizer	207	517
Phosphorus and potash	295	634
Nitrogen and potash	365	800
Phosphorus and nitrogen	544	903
Nitrogen, phosphorus, and potash	559	995

It is evident from these figures that nitrogen is a very important factor in the production of cotton. In experiments in Georgia on five soils typical of that region, it was calculated that the greater part of the increase in production was due to nitrogen and a relatively small part to phosphorus and potash.⁴³

Throughout the greater portion of the Cotton Belt, cotton production would be unprofitable without the use of commercial fertilizer year after year, but in several sections fertilizer is not required, notably in the Mississippi Delta and in much of Texas and Oklahoma. The percentage of acreage fertilized in 10 of the Cotton States is presented in table 25. The use of fertilizer was nearly universal in North Carolina where 98 percent of the acreage was fertilized, while only 1 percent of the cotton acreage in Oklahoma was fertilized. On the average, 95 percent of the land on which cotton was grown in the eastern group of States, 37 percent in the central group of States, and 3 percent

⁴²T. S. Bule and J. D. Warner, *Cotton Fertilizer Experiments* (S. C. Agr. Expt. Sta. Bull. No. 245, 1928), p. 31.

⁴³R. P. Bledsoe and Others, *Cotton Fertilizer for Georgia Soils* (Ga. Expt. Sta. Bull. No. 196, 1937), p. 20.

Table 25.- PERCENTAGE OF COTTON ACREAGE FERTILIZED AND AMOUNT OF FERTILIZER USED PER ACRE, BY STATES, 1936^a

State	Percent of acreage fertilized	Pounds of fertilizer used per acre ^b
Eastern group	95	300
North Carolina	98	410
South Carolina	98	350
Georgia	97	265
Alabama	90	255
Central group	37	182
Mississippi	55	195
Louisiana	36	155
Arkansas	20	165
Tennessee	31	190
Western group	9	160
Texas	3	160
Oklahoma	1	160

^a*Crops and Markets*, 14, No. 9 (Sept. 1937), 189. Includes commercial fertilizers only.

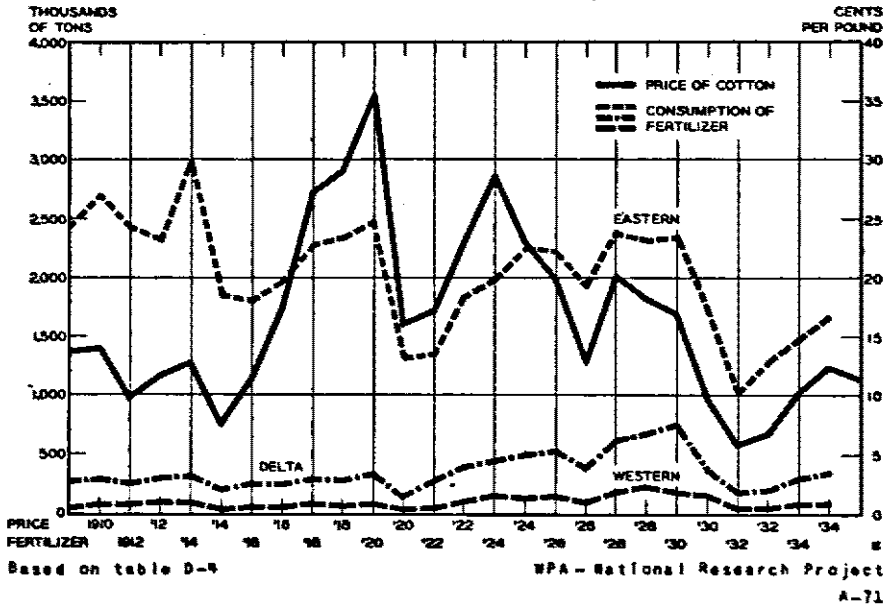
^bBased on acreage on which fertilizer was applied.

in the western groups of States was fertilized. In North and South Carolina 410 and 350 pounds per acre respectively were applied on the land fertilized, while in Texas and Oklahoma 160 pounds were used. Although the eastern group of States planted only 24 percent of the cotton in the States listed, they used 83 percent of the fertilizer; the central group planted 27 percent of the cotton and used 15 percent of the fertilizer; and the western group planted 49 percent of the cotton and used only 2 percent of the fertilizer.⁴⁴

Rather wide fluctuations have occurred in the tonnage of fertilizer used from year to year. These are closely associated with the price of cotton in the preceding year, as shown in figure 24. In the Delta Area there was some tendency toward increased use of fertilizer from about 1921 to 1930, after which a decided decline in consumption occurred. In the Western Cotton Area there has been some fluctuation in amount of fertilizer used but the amount has always been relatively small.

⁴⁴*Crops and Markets*, 14, No. 9 (Sept. 1937), 189.

Figure 24.- TOTAL FERTILIZER CONSUMPTION IN THE MAJOR COTTON-PRODUCING AREAS AND AVERAGE PRICE OF COTTON IN THE PRECEDING YEAR, 1909-36



The plant-food content of fertilizer sold in the Cotton States has increased materially since 1910, as shown by the following figures:⁴⁵

State	Percent of plant-food content	
	1910	1934
South Carolina	14.9	15.9
Georgia	14.9	16.2
Alabama	15.6	18.1
Mississippi	13.9	17.4
Arkansas	13.3	19.3
Louisiana	14.7	19.3
Texas	14.9	20.0

The amount of actual plant food applied throughout the South increased up to 1930. Since then the amount of fertilizer used has fallen off very materially.

⁴⁵L. Mehring and A. J. Peterson, *Changes in Composition of American Fertilizers, 1880-1932* (U. S. Dept. Agr. Circ. No. 315, 1934), pp. 13-8; records of U. S. Department of Agriculture, Bureau of Chemistry and Soils.

In the Eastern Cotton Area, where the greater part of the fertilizer is consumed, little change has occurred since 1909 in the percentage of farmers using fertilizer. The lowest percentage, 94, occurred in Tallapoosa County, Alabama, in 1909. A decrease has occurred in the percentage of farmers applying side dressing to their cotton with some form of nitrogen, as shown in table 26. There is considerable variation in the percentage of farmers following the practice of side dressing in this area, varying from 97 percent of the farmers in Darlington County, South Carolina, to only 7 percent in Brooks County, Georgia.

Table 26.- PERCENTAGE OF COTTON ACREAGE FERTILIZED AND SIDE DRESSED ON FARMS SURVEYED IN THE EASTERN COTTON AREA, 1909-36^a

County and State	Acreage	Percent of acreage		Acreage	Percent of acreage		
		Ferti-lized	Side dressed		Ferti-lized	Side dressed	
		1909			1919		
Eastern Cotton Area	7,510	98	52	10,465	99	50	
Tallapoosa, Ala.	885	94	11	1,262	98	8	
Marshall, Ala.	695	99	56	964	98	62	
Sumter, Ga.	1,873	100	61	2,757	99	53	
Brooks, Ga.	1,285	95	15	1,581	99	12	
Greene, Ga.	1,526	99	62	1,783	99	55	
Darlington, S. C.	1,246	99	91	2,118	100	93	
		1929			1936		
Eastern Cotton Area	11,708	98	47	7,771	99	47	
Tallapoosa, Ala.	1,392	95	10	1,003	99	9	
Marshall, Ala.	1,616	99	73	1,091	99	67	
Sumter, Ga.	2,626	99	40	1,618	100	44	
Brooks, Ga.	1,639	99	7	1,286	99	7	
Greene, Ga.	2,141	99	40	1,247	100	41	
Darlington, S. C.	2,292	99	92	1,526	100	97	

^aData obtained in NRP Farm Survey, 1936.

Table 27.- PERCENTAGE DISTRIBUTION OF FARMERS REPORTING THE APPLICATION OF NITROGEN, PHOSPHORUS, AND POTASH, BY AMOUNTS PER ACRE, EASTERN COTTON AREA, 1909-36^a

Amount in pounds	Nitrogen				Phosphorus				Potash			
	1909	1919	1929	1936	1909	1919	1929	1936	1909	1919	1929	1936
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than 2.5	0	0	0	0	1.8	0.4	0.5	0.5	1.8	0.3	0.2	0.2
2.5-7.4	0.9	1.5	1.9	2.5	46.1	42.7	18.0	12.3	44.8	33.7	17.5	11.6
7.5-12.4	9.0	7.3	9.0	13.6	39.7	37.7	49.2	43.6	42.5	46.8	54.1	55.0
12.5-17.4	17.0	10.6	11.2	17.1	4.6	7.8	15.9	21.8	5.0	9.4	16.5	20.2
17.5-22.4	25.5	24.8	22.9	22.8	2.7	5.3	8.0	7.5	3.2	6.1	7.7	7.4
22.5-27.4	14.1	19.0	21.7	18.2	3.2	3.9	4.3	5.7	1.3	2.0	2.6	4.2
27.5-32.4	17.9	21.5	18.8	18.0	0.9	1.4	3.4	5.2	0.9	1.3	0.9	0.9
32.5-37.4	6.6	4.4	2.9	3.4	0	0	0	0.5	0	0	0	0.2
37.5-42.4	9.0	10.6	10.2	4.2	0.9	0.7	0.7	1.8	0.5	0.3	0.5	0.2
42.5 or over	0	0.3	1.4	0.2	0	0	0	1.1	0	0	0	0

^aData obtained in NRP Farm Survey, 1936.

Very little change has occurred in the amount of nitrogen used per acre since 1909, although there has been a tendency in recent years toward lighter applications. This indicates that the use of leguminous green manure crops is effecting some saving to the farmer in the purchase of his fertilizer. On the other hand, there is a decided shift to higher rates of application of both phosphorus and potash. The percentage of farmers interviewed in the NRP Farm Survey who reported the application of less than 7½ pounds of phosphorus dropped from 46 percent in 1909 to 12 percent in 1936, while the percentage using from 12½ to 17½ pounds increased from 5 percent in 1909 to 22 percent in 1936. The increase in amount of potash is somewhat similar to that for phosphorus. For instance, the percentage of farmers using less than 7½ pounds has decreased from 45 percent in 1909 to 12 percent in 1936, while the percentage using 12½ to 17½ pounds increased from 5 percent in 1909 to 20 percent in 1936, as shown by table 27.

Fertilizer Placement

In the past, fertilizer has usually been drilled either by hand or by fertilizer distributors. The application is generally made about 10 days prior to planting at 3 to 4 inches below the surface of the soil.

As the average fertilizer today contains much more quickly soluble material than did the average fertilizer used 25 years ago, it must be applied with greater care than formerly in order to avoid interference with germination and early growth of the plant. In tests conducted in North Carolina, South Carolina, Georgia, and Mississippi an application of 800 pounds of a 4-8-4 fertilizer applied in bands 2, 3, and 4 inches under the seed resulted in yields of 824, 916, and 1,026 pounds of seed cotton per acre respectively. When the fertilizer was placed in two bands at the sides of the seed and 2 inches below the seed level, the yield was 1,220 pounds. With no fertilizer the yield was only 527 pounds.⁴⁸ Thus improved methods of placement seem capable of bringing material increases in yield without added labor or expense.

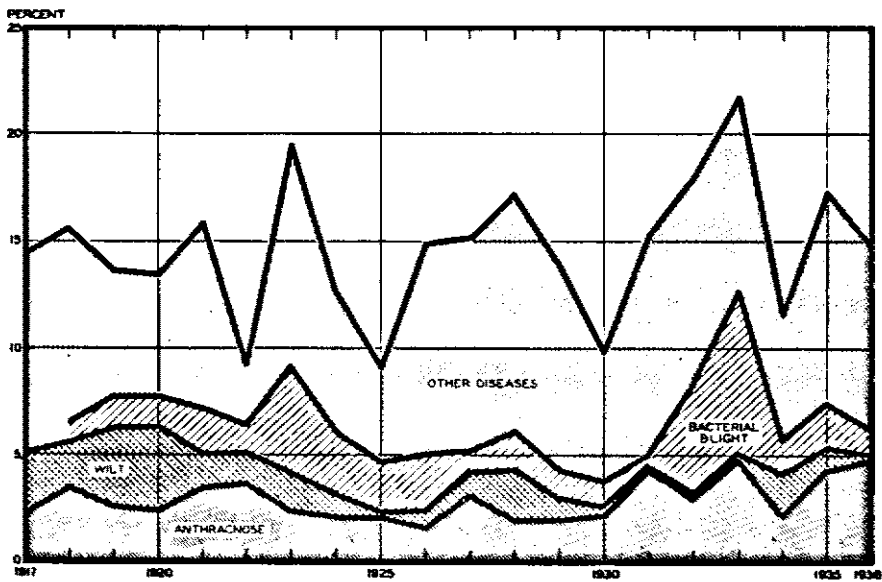
COTTON DISEASES

The cotton plant in most areas is subject to attack by diseases, some of which cause serious losses. Since 1917 these diseases

⁴⁸H. R. Smalley. "The Practical Side of Fertilizer Application Investigations," *The American Fertilizer*, LXXXIV, No. 7 (1936), 7-8.

have resulted in an estimated average reduction of 14 percent in the cotton crop, as shown by figure 25. In absolute amounts the loss has ranged from a low of 417,000 bales in 1922 to a high of 3,256,000 bales in 1926 which was, however, a year of high production. Losses from diseases, individually and collectively, are subject to drastic fluctuations.

Figure 25.- ESTIMATED REDUCTION IN YIELD OF COTTON CAUSED BY SPECIFIED DISEASES



Based on data from *Plant Disease Bulletin and Plant Disease Reporter* (U. S. Dept. Agr., Bur. Plant Industry)

WPA - National Research Project A-72

Root Rot

Root rot is caused by a fungus which lives in the soil and attacks and destroys the roots. It is confined largely to the highly calcareous and alkaline soils of the southwestern States and occurs especially in the heavy, black waxy soil areas in Texas. In this area it has been estimated to cause a loss of 10 to 15 percent of the cotton crop under normal conditions.⁴⁷ This disease resulted in a loss to the cotton crop of the United States in 1935 and 1936 amounting to 5 and 2 percent respectively.⁴⁸ No very satisfactory control measures have as yet

⁴⁷D. C. Neal and W.W. Gilbert, *Cotton Diseases and Methods of Control* (U. S. Dept. Agr. Farmers' Bull. No. 1745, May 1935), p. 2.

⁴⁸H. A. Edson, J. I. Wood, and N.W. Nance, "Crop Losses from Plant Diseases in the United States, 1935," *The Plant Disease Reporter* (U. S. Dept. Agr., Bur. Plant Industry, 1936), suppl. 94, p. 67; H. A. Edson and J. I. Wood, "Crop Losses from Plant Diseases in the United States, 1936," *The Plant Disease Reporter* (U. S. Dept. Agr., Bur. Plant Industry, 1937), suppl. 100, p. 71.

been developed, but the disease may be reduced if proper care is exercised. The following practices have been successfully employed in this endeavor: the rotation of cotton with small-grain crops, with deep tillage immediately after the grains are harvested; the application of organic manures in irrigated districts; the disinfecting of isolated centers with an ammonia or formaldehyde solution or ammonium compounds; and the construction of barriers to prevent spreading.⁴⁹

The length of rotation and the kind of crops included in it have some influence on the effectiveness of the control. In one instance where cotton followed cotton, the yield was 142 pounds of lint cotton and the damage to plants was 34 percent; while with cotton planted once in a 3- or 4-year rotation, yields of 215 to 276 pounds were obtained, with damage to plants amounting to 6 to 13 percent.⁵⁰

Fusarium Wilt

Fusarium wilt is caused by a fungus which lives in the soil and infects the plant through the roots. Toxic substances given off by its growth accumulate in the cells of the plant in sufficient quantities to cause wilting and death. The disease is especially prevalent in the light sandy soils of the Coastal Plain. Under severe conditions the disease may reduce the yield by as much as 75 to 90 percent. The only effective control is achieved through the use of wilt-resistant varieties stimulated by generous quantities of fertilizer. Since the organism which produces the disease is able to live in the soil for several years, crop rotation is ineffective as a means of control.⁵¹

Verticillium Wilt

This disease is caused by a soil fungus which enters the roots in the same manner as that causing fusarium wilt. The fungus causes wilting, mottling, and shedding of the leaves. The greatest loss from this disease occurs in the Mississippi Delta, where infection varies from a trace to as much as 40 percent. The disease is also prevalent in Texas and throughout the irrigated districts of New Mexico, Arizona, and California.⁵² There is,

⁴⁹Neal and Gilbert, *op. cit.*, pp. 5-8.

⁵⁰E. B. Reynolds and D. T. Killough, *Crop Rotations in the Blackland Region of Central Texas* (Tex. Agr. Expt. Sta. Bull. No. 365, 1927), pp. 8-10.

⁵¹Neal and Gilbert, *op. cit.*, pp. 6-12.

⁵²U. S. Dept. Agr., press release 1270-37, March 11, 1937.

as yet, no known control measure for this disease; however, rotation with alfalfa or grain crops is suggested as a means of reducing infection.⁵³

Pima Egyptian cotton has been found to be immune to the disease, while upland varieties show differing degrees of susceptibility. Therefore there is a possibility of breeding for *Verticillium*-wilt resistance.⁵⁴

Root Knot

Root knot is caused by nematodes which bore into the roots, where they multiply, living at the expense of the cotton plant and forming galls or swellings on the roots. This disease, like wilt, is most common on light sandy soils of poor water-holding capacity. Losses to the cotton crops are as much as 4 percent annually in some States. Rotation of cotton with nonsusceptible crops so as to starve out the nematodes in infected fields is the most practical remedy.⁵⁵

Bacterial Blight or Angular Leaf Spot

This disease is caused by a bacterium which enters the leaves, stems, and bolls through the stomata and kills the adjoining cells, producing spots on the leaves, decay of the bolls, and dead areas on the branches. The organisms causing the disease live over the winter chiefly on the seed and possibly on the diseased portions of cotton bolls and stalks left on the ground. The average annual reduction in yield of upland cotton due to this disease is somewhat more than 2 percent.

Bacterial blight can be controlled by using disease-free seed, or seed may be practically sterilized of the blight bacteria if treated with special dust disinfectants or if delinted with sulphuric or hydrochloric acid.⁵⁶

Anthracnose

Anthracnose is caused by a fungus which lives over the winter on crop refuse that remains in the field. The disease is also perpetuated by the organisms overwintering in and on the seed from infected plants. This disease results in the greatest loss

⁵³Neal and Gilbert, *op. cit.*, pp. 12-4.

⁵⁴U. S. Dept. Agr., Press release 1270-37, March 11, 1937.

⁵⁵Neal and Gilbert, *op. cit.*, pp. 14-7.

⁵⁶Neal and Gilbert, *op. cit.*, pp. 19-23.

in localities where cotton attains a rank growth, or where rainfall occurs at frequent intervals during the growing season. It is most common in the mid-South and the southeastern States. In some localities only a fraction of 1 percent of the crop is lost from this disease, while in others the losses may range from 40 to 60 percent.

Effective control can be secured by selection of seed from disease-free plants and by avoidance of susceptible varieties, such as Half and Half and Cook. Rotation of crops is an effective supplemental control, since it reduces possible infection from diseased bolls and stalks which remain on the land. It is also possible to control the disease by using 2- and 3-year-old seed, since the fungus in the seed dies after 12 to 14 months.⁵⁷

TREATING COTTONSEED FOR PLANTING

The small cotton seedling and the young plant are very tender and, if subjected to unfavorable weather during the early stage of growth, fall easy prey to any one of numerous diseases. In some years a large number of farmers find it necessary to plant their cotton a second and sometimes a third time before a satisfactory stand is secured. This has been especially true, since the advent of the boll weevil, which has made it highly desirable to plant cotton as early as possible and before the soil becomes warm enough for quick germination. It is under such conditions and where the cottonseed carries disease that seed treatment is effective in producing higher yields.

The possibility of delinting cottonseed with concentrated acid has been known for many years. The first suggestion of this method of treatment appeared in two British patents granted in 1874 and 1875.⁵⁸ The delinting of cottonseed mechanically and with acid has been practiced to some extent. The use of concentrated sulphuric acid to delint cottonseed has been effective in increasing yield by as much as 25 percent. Its adoption was retarded until recently, when a continuous-process unit (delinting, sterilizing, and drying) was developed. The units now in operation have a capacity of 1 ton of seed per hour. In

⁵⁷ Neal and Gilbert, *op. cit.*, pp. 18-9.

⁵⁸ W. J. Murphy, "Delinting Cotton Seed," *Chemical Industries*, XXXVIII, No. 11 (1936), 128-9.

1935 four of these delinting units were in operation, with indications that their number would increase in following years.⁵⁹

The delinting of cottonseed allows for quicker germination and reduces losses from damping off, thus resulting in earlier maturity. Acid delinting of cotton will undoubtedly be confined largely to the areas of the Cotton Belt where soil moisture can be controlled, as in the irrigated sections of the Southwest. The use of this practice will be limited in other sections because of the danger of poor stands. When wet, cold soil conditions follow planting, delinted seed may rot, resulting in a poor stand, whereas fuzzy seed may give a fair stand.

Where delinted seed is also treated with an organic-mercury compound, it is often possible to plant much earlier than would otherwise be advisable. The protection afforded by the treatment of seed with chemical dusts is not of recent origin.⁶⁰ However, the present interest in the use of organic-mercury dusts to control certain diseases and to improve cotton production is relatively new. In contrast to the difficult task of delinting cottonseed by the use of acid, treating seed with chemical dusts is relatively simple and can be accomplished on almost any farm without much expense. The average cost to treat seed is about 25 cents an acre.⁶¹

By the use of organic-mercury dusts the stand of cotton may be increased in many sections of the Cotton Belt by 25 to 75 percent before chopping and 10 to 30 percent after chopping, with an increase in yield of 10 to 20 percent, or greater under severe conditions.⁶² The use of organic-mercury dusts for disinfecting cottonseed was reported as used on approximately 25,000 bushels in Georgia, 60,000 in South Carolina, and 30,000 bushels in North Carolina in 1936.⁶³

The indications are that these dusts will continue to be used in increasing quantities as time goes on. The cost of labor in

⁵⁹*Ibid.*

⁶⁰H. P. Smith and Others, *Chemical Dust Treatment of Cottonseed for Planting Purposes* (Tex. Agr. Expt. Sta. Bull. No. 531, 1936), p. 6.

⁶¹Luther Shaw, "Why and How to Treat Cotton Seed," *Plant Disease Notes* (N. C. Agr. Ext. Ser., mimeo., 1937), II, No. 1.

⁶²*Ibid.*; Smith and Others, *op. cit.*, p. 22; H. B. Brown and Others, *Crops and Soils Information, I* (La. Agr. Expt. Sta. Bull. No. 283, 1937), p. 12; C. H. Arndt, "Cotton Seedling Diseases," *Forty-ninth Annual Report* (S. C. Expt. Sta., 1936), p. 36; H. C. Bucha, "Some Observations on Treating Cotton Seed with Descriptions of the Methods Followed," *Agricultural News Letter*, V, No. 3 (Wilmington, Del.: E. I. du Pont de Nemours & Co., Inc., Publicity Department, 1937), pp. 63-6.

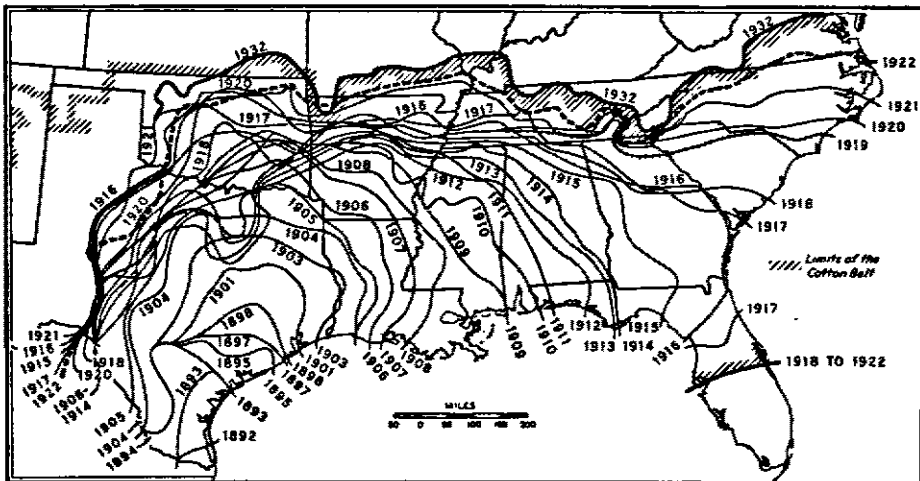
⁶³Records of Extension Service, U. S. Department of Agriculture (1937).

treating seed is about 5 cents a bushel, which would be 1.5 million dollars for a 30,000,000 acre crop of cotton.⁶⁴

INSECT ENEMIES OF THE COTTON PLANT

There are about 25 insects which attack the cotton plant, many of which cause only minor losses. The major losses are due to the boll weevil, the cotton leaf worm, and the bollworm.

Figure 26.- SPREAD OF THE COTTON BOLL WEEVIL, 1892-1932



Bureau of Agricultural Economics, U.S.D.A.

Cotton Boll Weevil

History.— The cotton boll weevil was brought to this country in 1892. Within 30 years the infestation of the Cotton Belt was practically complete except for some of the more northern and irrigated regions of production, as indicated by figure 26.

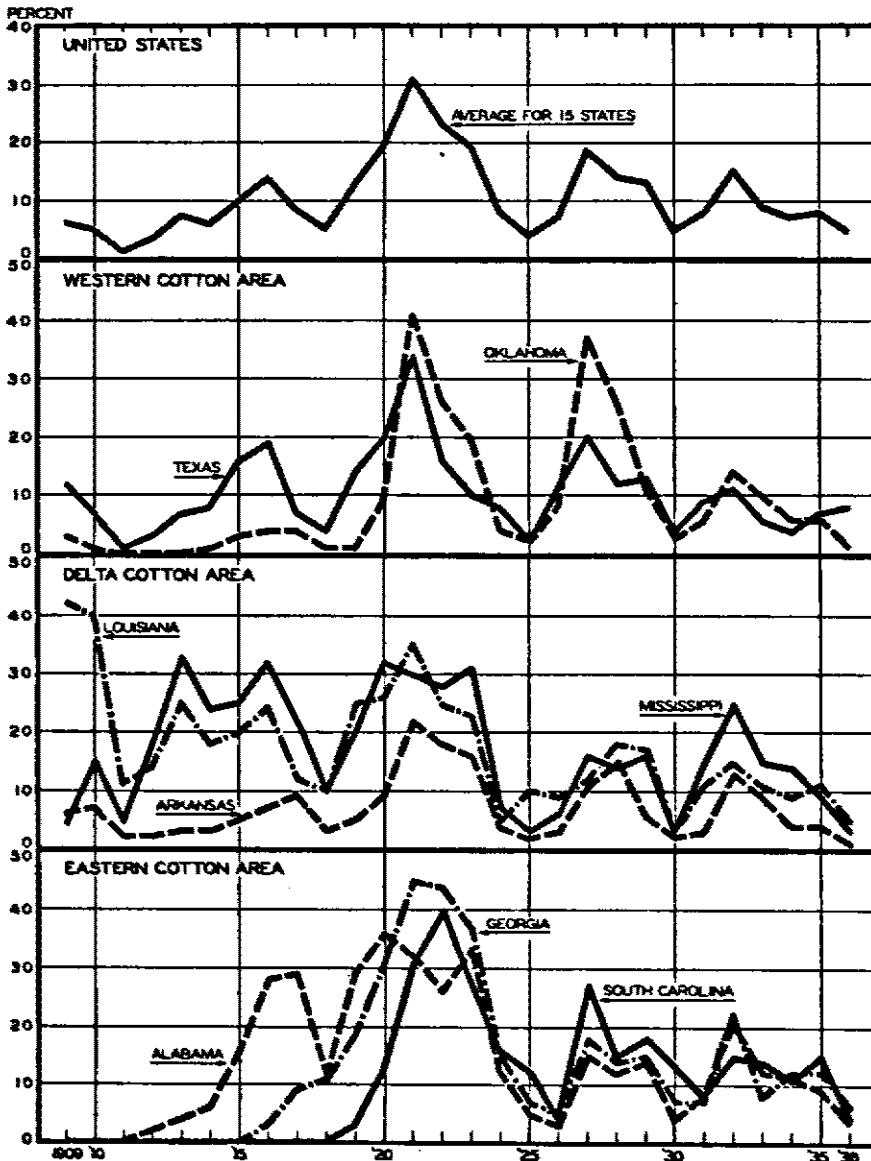
Losses resulting from boll-weevil damage have been estimated at as high as \$200,000,000 in a single year. For the period 1910 to 1928 the average annual loss has been estimated at 12 percent of the cotton crop.⁶⁵ In figure 27 is presented the percentage reduction from full yield as a result of damage to the cotton crop by the boll weevil. The maximum reduction of over 30 percent occurred in 1921, with other peak years 1916, 1927, and 1932. It would appear from these data that heavy losses

⁶⁴ *Ibid.*

⁶⁵ J. A. Hyslop, *An Estimate of the Damage by Some of the More Important Insect Pests in the United States*, (U. S. Dept. Agr., Bur. Ent., mimeo., Dec. 31, 1930), p. 4.

caused by the boll weevil in the past have had a tendency to recur at intervals of about 5 years. The boll weevil took its first heavy toll in Louisiana in 1909 and 1910; in Mississippi

Figure 27.- ESTIMATED REDUCTION IN YIELD CAUSED BY THE BOLL WEEVIL, 1909-36



Based on The World Cotton Situation, "Part II. Cotton Production in the United States" U. S. Dept. Agr., Bur. Agr. Econ., prelim. mimeo., Feb. 1936, table 19

in 1913; in Alabama in 1916 and 1917; in Arkansas in 1921; in Georgia in 1921 and 1922; and in South Carolina in 1922. These dates of first heavy reduction in production reflect the movement of the cotton boll weevil to the east and to the north.

The invasion of the boll weevil brought about reductions in the acreage planted to cotton in the affected regions. In Alabama the acreage dropped from over 3,750,000 acres in 1914 to about 2 million acres in 1917; likewise in Georgia the acreage dropped from over 4,250,000 acres in 1921 to approximately 2,750,000 acres in 1923; and in South Carolina from over 2,750,000 in 1918 to about 1,600,000 acres in 1923. There is some indication that recovery in acreage was quickest in Georgia and South Carolina, possibly because better-adapted varieties were available and methods and means of combating the boll weevil were better known by the time the weevil reached these States.

Control Measures.— There are a number of control measures, such as planting of early-maturing varieties, closer spacing, use of fertilizer, and earlier planting. When these measures fail, and the insects appear in sufficient numbers (usually when 10 percent of the squares, or young bolls, have been punctured), growers find it desirable to apply some kind of insecticide.

Shortly after the boll weevil first appeared in Texas, attempts were made to control it with various insecticides. Not until 1914 was a poison found, calcium arsenate, that brought effective control.⁶⁶ The most effective method of direct control is to dust with calcium arsenate, when the cotton plants are moist and the air is calm, at the rate of 4 to 6 pounds per acre. The number of applications necessary depends upon the degree of infestation and upon weather conditions.⁶⁷

At first most of the poison was applied by the use of hand-operated machines carried by the operator and capable of caring for about 8 acres of cotton in a season. This type of machine is still used to some extent but has been replaced by saddle, traction, and power dusters, and more recently by airplane dusters. While the power duster, operated by one man, is capable of caring for 300 to 500 acres of cotton a year, the airplane is

⁶⁶B. R. Coad, *Recent Experimental Work on Poisoning Cotton Boll Weevils* (U. S. Dept. Agr., Bur. Ent., Bull. No. 731, 1918).

⁶⁷J. W. Folsom, *Insect Enemies of the Cotton Plant* (U. S. Dept. Agr. Farmers' Bull. No. 1688, 1932), p. 3. For a more complete review of literature on insecticides for boll weevil, see H. J. Reinhard and F. L. Thomas, *Ingestion of Poison by the Boll Weevil* (Tex. Agr. Expt. Sta. Bull. No. 475, 1933), p. 33.

capable of treating 300 to 500 acres in an hour and caring for 3000 to 4000 acres per year.⁶⁸ The airplane was first used to dust cotton at the Bureau of Entomology Laboratory at Tallulah, Louisiana, in 1922. At the present time there are several companies that operate airplane dusting service. This type of dusting is rapidly increasing in Texas and the delta area of Mississippi, where the fields are relatively large in size. The cost of treating is considered to be no greater than when fields are dusted by other means.⁶⁹

The Cotton Leaf Worm and the Bollworm

The cotton bollworm has been estimated to cause an average annual loss of about 2 percent of the cotton crop amounting to some 24 million dollars during the period 1910-28, while the cotton leaf worm was estimated to cause an annual loss equal to about one-third this amount.⁷⁰ The leaf worm, especially the early broods, by destroying the leaves of the cotton plant, often prevents the bolls from maturing. It is very destructive and feeds only on cotton. Unlike the leaf worm, the bollworm feeds upon about 70 plants, but it favors cotton among a few others. The bollworm feeds only lightly on the foliage. It attacks the flowers or bores into the squares or bolls and here causes considerable damage. The best means of control of both these insects is similar to that for boll weevil, that is, dusting with calcium arsenate.⁷¹

⁶⁸F. L. Thoms and Others, *Boll Weevil Control by Airplane Dusting* (Tex. Agr. Expt. Sta. Bull. No. 394, Apr. 1929), p. 33; R. C. Gaines and D. A. Isler, *Machinery for Dusting Cotton* (U. S. Dept. Agr. Farmers' Bull. No. 1729, July 1934).

⁶⁹Edgar Chestnutt, "Wings Over Weevil," *American Cotton Grower*, 11, No. 2 (July 1936), 6-7.

⁷⁰J. A. Hyslop, *op. cit.*, pp. 5, 6, 10.

⁷¹Folsom, *op. cit.*, pp. 4-7. For a more complete list of cotton insects, see Folsom, *op. cit.*

SECTION V

SUMMARY AND CONCLUSIONS¹

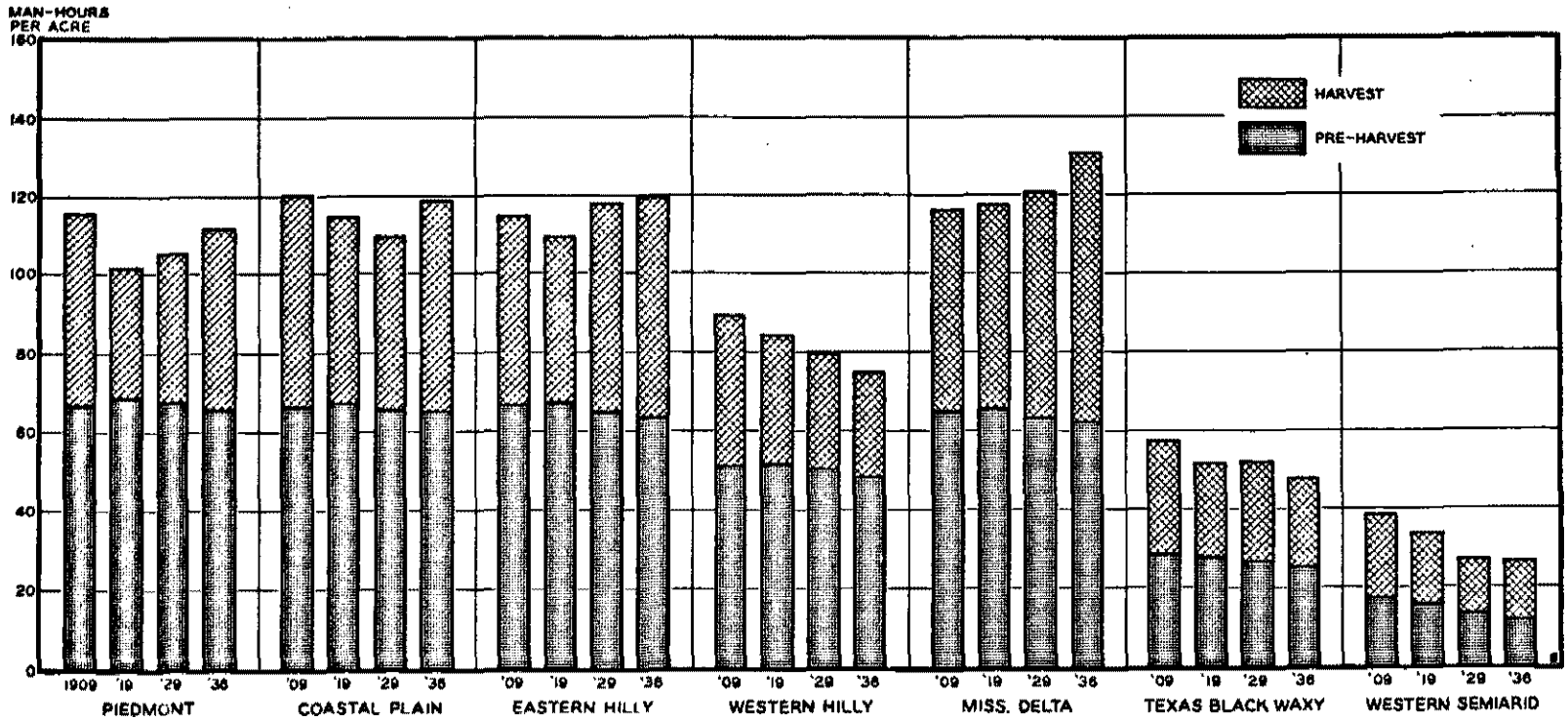
Although the acreage devoted to the production of corn, hay, or wheat far exceeds that planted in cotton, the production of cotton consumes far more labor. The great amount of labor required for cotton production may perhaps best be appreciated through the fact that cotton land is gone over from 15 to 20 times in the course of the year, except in the Western Semiarid Section. Within sections there has been practically no change in the number of times over the land since 1909. Of course, the amount of labor is not directly proportionate to the number of operations performed, since some require much more time than others. These facts do suggest, however, that little progress has been made in combining operations - one of the usual means of simplifying crop production and reducing labor requirements.

Although the general process of cotton growing has remained essentially unchanged since 1909, there are other possibilities of reducing the number of hours per acre in producing the crop. Chief among these are the adoption of mechanical power or larger teams, and of larger equipment. To what extent have these means reduced the total amount of labor required to raise the cotton crop of the country?

In answering this question it is necessary to take into consideration the effect of shifting acreages into areas where labor requirements are lower, since the average labor requirements for the country as a whole might thus be reduced considerably without any change in the amount of labor per acre within any individual area. Having this point in mind, we will take up, first, the changes that have occurred in the areas that were surveyed in the 1936 field study. Next, partly on the basis of these figures and partly on information obtained from studies made by the United States Department of Agriculture and various State experiment stations, we will present estimates of total amounts of labor used in cotton production for principal areas and for the country as a whole.

¹This section was prepared by William C. Holley.

Figure 28.- LABOR USED PER ACRE IN PRODUCING COTTON ON FARMS SURVEYED, 1909-36



Based on table 28

WPA - National Research Project

CHANGES IN LABOR USED IN GROWING COTTON ON FARMS SURVEYED

Eastern Sections

In 1936 the amount of labor used per acre previous to harvesting on farms surveyed in the Piedmont and Coastal Plain Sections was approximately 65 hours, and in the Eastern Hilly Section, 63 hours, as shown in table 28 and figure 28. Since 1909 there has been a reduction of about 1 hour per acre in the Piedmont and Coastal Plain Sections and about 3 hours in the Eastern Hilly Section. Most of this reduction occurred in the operations of hoeing, chopping, and cultivating, while there was a slight increase in the amount of labor used in distributing fertilizer and in dusting or spraying.

When the labor in picking cotton is added we find that in these three sections the total labor per acre since 1909 has amounted to between 100 and 120 hours, with most of the difference attributable to the variations in yield. The differences in yield are also reflected in the figures on hours of labor used per bale of cotton produced. It will be noted that when yields are high, the hours used to harvest an acre tend to rise while the total hours used to produce a bale of cotton decline.

Western Sections

In the hilly section west of the Mississippi River the amount of labor used per acre prior to harvesting was about a fourth less than in the three sections mentioned above. The use of one-row equipment and the low percentage of cotton acreage fertilized were the principal causes for smaller labor expenditures. Since 1909 the labor used per acre prior to harvest has decreased about 5 percent, chiefly as a result of the substitution of one-row for one-horse or one-half-row equipment in seedbed preparation and in cultivation.

Average yields on the farms studied in the Western Hilly Section, however, were only about two-thirds as high as in the three sections farthest east. Consequently, much less time was needed in picking cotton. The total labor used per acre, therefore, amounted to only 89 hours in 1909 and had declined to 75 hours in 1936, partly because of low yields in the latter period. With the decline in yields the labor used to produce a bale of cotton increased from 242 hours in 1909 to 262 in 1936.

Table 29.- LABOR REQUIREMENTS FOR COTTON PRODUCTION
ON FARMS SURVEYED, 1909-36^a

Section	Year	Yield ^b (pounds of lint per acre)	Man-hours per acre			Man- hours per bale, total
			Pre- harvest	Harvest	Total	
Coastal Plain	1909	231	66.2	53.9	120.1	252
	1919	209	66.8	47.7	114.5	263
	1929	196	65.4	44.3	109.7	264
	1936	239	65.0	53.5	118.5	237
Piedmont	1909	210	66.6	49.1	115.9	266
	1919	143	68.8	32.7	101.5	335
	1929	170	67.3	37.9	105.2	294
	1936	209	65.7	45.7	111.4	256
Eastern Hilly	1909	245	66.3	48.4	114.7	229
	1919	225	66.7	42.8	109.5	230
	1929	299	64.8	53.0	117.8	188
	1936	321	63.2	56.3	119.5	179
Western Hilly	1909	174	51.2	38.1	89.3	242
	1919	159	51.4	32.9	84.3	253
	1929	154	50.1	29.8	79.9	247
	1936	138	48.4	26.5	74.9	262
Mississippi Delta	1909	224	65.3	51.5	116.8	246
	1919	227	65.6	52.0	117.6	247
	1929	252	63.3	57.6	120.9	229
	1936	302	62.1	68.7	130.8	210
Texas Black Wax	1909	199	28.8	28.4	57.2	137
	1919	172	28.0	23.4	51.4	143
	1929	177	26.6	25.0	51.6	139
	1936	170	25.4	22.3	47.7	134
Western Semiarid	1909	127	17.2	21.4	38.6	147
	1919	163	15.6	17.9	33.5	97
	1929	142	13.1	13.9	27.0	92
	1936	176	11.7	14.9	26.6	72

^aData obtained in NRP Farm Survey, 1936. See appendix C for data for individual counties in these sections.

^bYield based on average of counties surveyed (U. S. census data) weighted by number of records obtained in each.

In the Mississippi Delta about the same amount of labor per acre was used in 1936 as in the Eastern Hilly Section. Decidedly more hours per acre, however, were spent in hoeing and chopping and in cultivating, while less labor was used in flatbreaking, distributing fertilizer, and planting. Since 1909 there has been a reduction of about 3 hours per acre prior to harvest, principally because of the use of larger equipment and tractors in later years. Labor used in distributing fertilizer (which has almost trebled) and in dusting and spraying has increased greatly.

With relatively high yields and high labor requirements in picking, the total hours per acre run even higher than in the eastern sections. Since 1909 they have increased in spite of the saving in labor prior to harvest. The increased yields, however, were sufficient to overcome the increases in labor per acre, so that there was a decline of labor per bale from 246 hours in 1909 to 210 in 1936.

In 1936 the amount of labor used per acre previous to harvesting in the Texas Black Waxy Section was only 25.4 hours, or only about 40 percent as great as in the sections from the Mississippi River to the east, and approximately 53 percent as much as in the Western Hilly Section. Larger equipment, drawn by large teams or tractors, and the performance of fewer operations were the principal reasons for the difference. The amount of labor used for hoeing and chopping was about one-half and that for cultivating about one-third as much as in the eastern sections. Preharvest labor per acre has declined about 3 hours since 1909, chiefly because of larger units of power and equipment. With only moderate yields, the labor for harvesting was even lower than in the Western Hilly Section. Consequently, the total labor per acre amounted to only 57 hours in 1909 and to 48 in 1936. About a third of this apparent decline, however, may be attributed to the lower yield in the most recent period.

The lowest labor requirements per acre were found in the Western Semiarid Section. In 1936 only 11.7 hours were used per acre prior to harvesting. In some parts of this section the representative number of hours per acre is even lower than this. Multirow equipment, greater use of tractors, and fewer operations, together with the small amount of hand labor, account for the small number of hours. Since 1909 there has been a reduction of about 34 percent in labor per acre prior to harvesting.

Among all the sections studied, the Western Semiarid Section showed the smallest amount of labor per acre, both in preharvest and in harvesting operations. The total declined from 38.6 hours in 1909 to 26.6 hours in 1936. Reductions occurred in both preharvest and harvest labor through the increased use of multirow machinery and by substituting snapping for picking. It should be remembered that the yields in this section are typically low and also that the snapped cotton is of a lower grade than the cotton picked carefully by hand in eastern sections. Nevertheless, the decline in hours per acre, as well as the small number of hours of labor needed to produce a bale of cotton, are strong indications of the effect of mechanization on labor requirements in cotton production.

CHANGES IN TOTAL LABOR USED IN COTTON PRODUCTION

For the purpose of estimating changes in the total amount of labor used in producing cotton in the United States, the cotton-producing States were divided into six areas; the Eastern, Delta, Western, Middle Eastern, and Irrigated Areas, and all other States producing cotton.² Data from earlier studies conducted by the United States Department of Agriculture and the State experiment stations, as well as those obtained by the NRP Farm Survey, were used in estimating the number of hours used per acre in 1909, 1919, 1929, and 1936 for cotton harvested³ and the labor used on abandoned acreage.⁴ The labor rates for each type of farming section of a State were weighted by census acreage data to obtain a State estimate. These hours per acre for States were weighted by 5-year average acreages to obtain a rate for each area (for instance, 1927-31 averages were used for 1929).⁵ The average hours for each area were then applied to the respective acreages in each area in computing the average hours per acre for the United States.

²The Eastern Area includes South Carolina, Georgia, and Alabama. The Delta Area includes Mississippi, Louisiana, and Arkansas. The Western Area includes Oklahoma and Texas. The Middle Eastern Area includes Virginia, North Carolina, and Tennessee. The Irrigated Area includes New Mexico, Arizona, and California. All other States include Florida, Illinois, Kansas, Kentucky, and Missouri.

³Labor for marketing (when cotton was not sold at gin) was not included.

⁴In estimating labor used on abandoned acreage, a total equivalent to the labor for seedbed preparation and planting, one-half the requirements for hoeing and chopping, and requirements for 2 cultivations was used.

⁵However, 4-year average acreages (1933-36) were used to weight 1936 labor requirements.

Estimated Labor Per Acre and Per Bale

The estimated hours used for producing an acre of cotton are shown in table 29, and, for the major areas, in figure 29. In the period 1933-36, according to these estimates, an average of 85 hours was used per acre actually harvested. When the labor spent on abandoned acreage is included, labor requirements become 88 hours per harvested acre.

Since the period 1907-11 there has been a 16-percent reduction in the amount of labor required to produce an acre of cotton. This includes the labor on abandoned acreage. The reduction in the over-all averages for the country is caused in part by shifting of production from high-labor-requirement areas to others of lower requirements, and in part by labor savings within the areas, both in preharvest and in harvest operations. The average total labor per bale⁶ amounted to 218 hours for the United States in the period 1933-36. This may be compared with 271 hours per bale in the period 1907-11, a reduction of about 19 percent.

In the Eastern Area 123 hours were used in producing an acre of cotton in the period 1933-36, or 35 hours more than the average for the United States. The high labor requirements resulted largely from small cotton acreages per farm, the use of small horse-drawn implements, the large amounts of fertilizer applied, and the great amount of labor used in hoeing, chopping, and harvesting. The reduction here since 1907-11 has amounted to 7 hours per acre.

The time used in producing an acre of cotton in the Delta Area was about 6 percent less than that in the Eastern Area and one-third greater than the average for the United States. A slight reduction in the number of hours has been effected chiefly by the increased use of large equipment.

More labor was used in the Middle Eastern Area than in any other part of the United States. This is explained by the use of small, horse-drawn implements, the application of large amounts of fertilizer, and the great amount of hand labor. Labor savings effected in harvesting and a few minor changes in cultural practices account for a slight reduction since the period 1907-11.

In terms of man-hours per bale of cotton produced, more labor was used in the Eastern and Delta Areas than in any other part

⁶500-lb. bale, gross weight (includes bagging and ties and contains an average of about 478 lbs. of lint).

Table 29.- ESTIMATED LABOR REQUIREMENTS FOR COTTON PRODUCTION
IN MAJOR COTTON AREAS, 1909-36^a

(Average per year)

Item and year	United States ^b	Major cotton-producing areas				
		Eastern	Middle Eastern	Delta	Western	Irrigated ^c
Acres harvested^d						
(thousands)						
1907-11	31,759	10,483	2,041	6,480	12,374	4
1917-21	32,655	9,282	2,204	6,489	14,208	201
1927-31	41,031	8,598	2,608	8,927	19,875	532
1933-36	28,410	5,800	1,836	6,364	13,443	513
Man-hours required						
per acre ^e						
1907-11	105	130	139	122	70	122
1917-21	95	120	136	114	62	109
1927-31	85	113	132	110	54	118
1933-36	88	123	130	116	50	127
Man-hours required						
on total acreage (millions)						
1907-11	3,343	1,358	285	793	863	*
1917-21	3,089	1,115	301	738	863	22
1927-31	3,493	974	345	982	1,072	63
1933-36	2,489	716	238	739	673	65
Cotton produced^d						
(thousands of bales)						
1907-11	12,332	4,536	1,072	2,597	3,997	3
1917-21	11,219	3,550	1,132	2,369	3,967	102
1927-31	14,658	3,452	1,291	3,615	5,651	416
1933-36	11,432	2,832	1,055	2,955	3,791	515
Man-hours used per						
bale ^f						
1907-1911	271	299	268	305	216	183
1917-21	275	314	268	312	223	216
1927-31	298	282	267	272	190	151
1933-36	218	253	226	250	176	126

^a Based on data from NRP Farm Survey, 1936, and from earlier studies conducted by the U. S. Department of Agriculture and by State experiment stations. Labor requirements for marketing (when cotton was not sold at gin) are excluded from the estimates.

^b Includes all cotton-producing States.

^c Includes New Mexico, Arizona, and California.

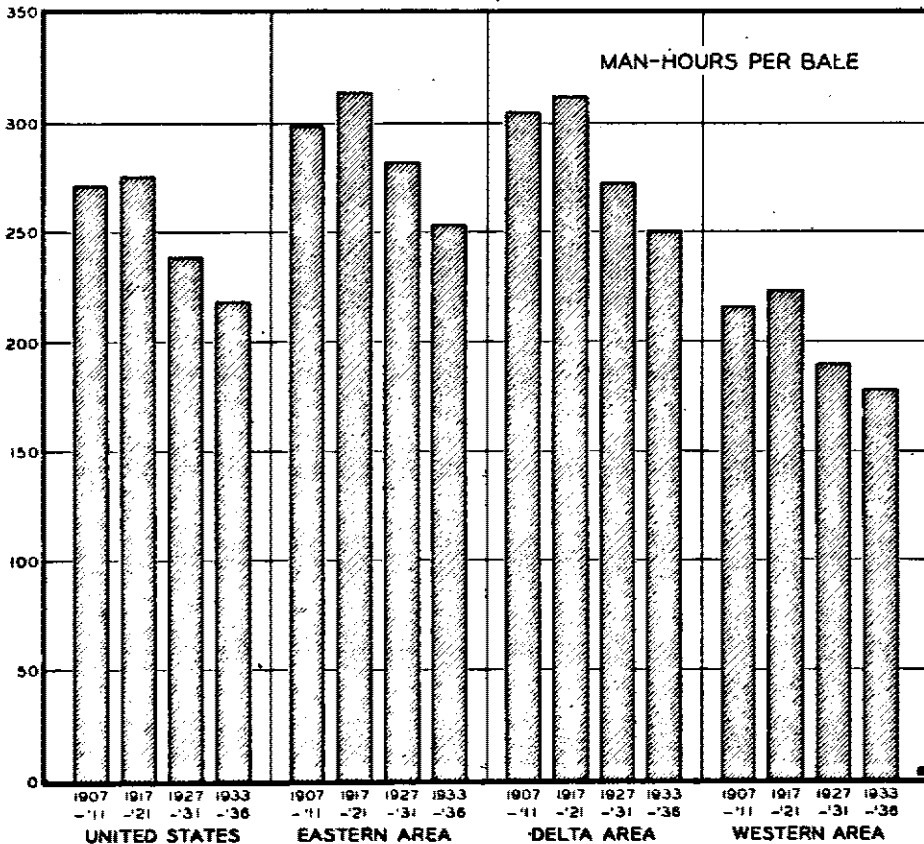
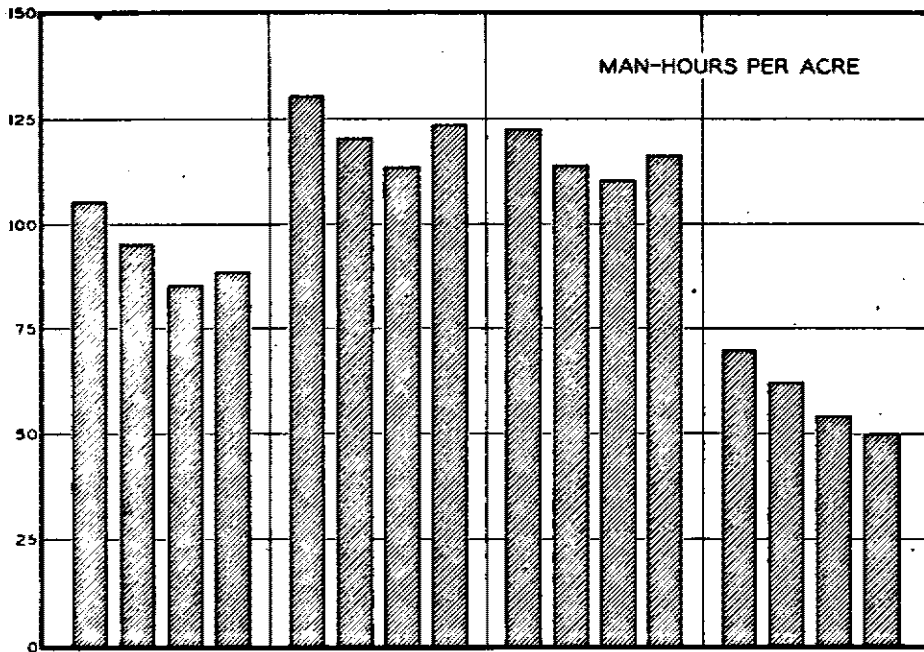
^d Based on figures from appendix A.

^e Hours are per acre harvested, but include estimated hours spent on abandoned acreage. See appendix E.

^f 500-lb. bale, gross weight (includes bagging and ties and contains about 478 lbs. of lint). Labor on abandoned acreage is included.

* Less than 500,000.

**Figure 29.- LABOR USED PER ACRE AND PER BALE IN
PRODUCING COTTON IN MAJOR AREAS
1907-11 to 1933-36**



Based on table 29

WPA - National Research Project

of the United States. During the period 1933-36 this amounted to 253 and 250 hours respectively in these areas, including labor on abandoned acreage. Since the 1907-11 period the reduction per bale has amounted to 15 percent both in the Eastern Cotton and the adjacent Middle Eastern Areas. In the Delta Area, where there has been more change in methods and equipment, a slightly greater reduction (18 percent) was obtained.

Less labor was used per acre of cotton in the Western Cotton Area than in any other. In 1933-36 the average was 50 hours per acre, or 38 hours less than the average for the United States. This difference was caused by the use of large equipment, less hand labor, and fewer operations, as well as by smaller yields which required less time to harvest. Since the period 1907-11 a reduction has been effected of about 29 percent in labor per acre. This is due to the increased use of large machinery and greater power units.

On the basis of labor per bale, however, the advantage of the Western Area is much less than it is on the basis of labor per acre, as may be seen in figure 29. In the period 1933-36, 178 hours were used per bale, or 18 percent less than the 216 hours used in 1907-11. The labor per acre here in 1933-36 was only 42 percent as great as the average for the Eastern and Delta Areas combined, while the labor per bale was 70 percent as great as the average for these two areas combined for the same period. To this must be added the consideration that much of the cotton, particularly in the Western Semiarid Section, is of shorter staple than it is in eastern areas and is harvested by snapping. Both of these mean lower quality and lower price. Thus the economic advantage of the western areas over the eastern areas is smaller than many persons believe.

In the period 1933-36 an average of 127 hours per acre was used in the Irrigated Area. The high figure here is largely the result of labor expenditures for irrigation, hoeing, chopping, and harvesting. The latter requires large amounts of hand labor because of high lint yields per acre. No appreciable change in the hours per acre has been effected since the period 1907-11. The yield per acre increased about one-third, however, and this brought a decline in the hours per bale.

The changes in the hours per bale, as well as per acre, were also influenced by shifts in the type of cotton grown. In Arizona a large proportion of the cotton grown in the 1917-21 period was

of the Egyptian type. This type yields much less per acre than does the American type grown in the same area, but it requires much more labor per bale to pick the Egyptian cotton. By 1927-31 most Egyptian cotton had been replaced by the American type, leading to a simultaneous increase in yield per acre and decrease in hours required for harvesting.

Aside from the Irrigated Section, which is relatively small in acreage and production, there was no area in which the reduction in labor per bale was quite so great as the average for the country as a whole. The explanation lies in the fact that the change in the average for the country was affected by the shifting of acreage to the Western Area where labor requirements are low, as well as by changes within individual areas. This does not mean, however, that the changes within areas were unimportant, since they actually amounted to 15 to 18 percent in each area.

Shifts in Cotton Acreage Between Areas

The changes in acreage raised in each major area will be observed in table 29. Between the periods 1907-11 and 1927-31 the acreage of cotton in the Eastern Cotton Area decreased 18 percent while it increased 38 percent in the Delta Area and 60 percent in the Western Area. What were the causes of these changes?

In the Eastern Area the invasion by the boll weevil was relatively recent, as may be seen in figure 21, and in some sections its influences were still felt to a greater degree than in the areas farther west. In each successive State which it invaded the weevil caused a sharp drop in cotton acreage for a period of at least 3 or 4 years, and there was less subsequent recovery in this area than in the others.

In the Piedmont and Eastern Hilly Sections the advance of erosion was a factor of importance. So were the low prices of cotton which resulted in part from increased production in the Delta and Western Areas. Finally, it is not unlikely that the increase in textile manufacture and in other industries in this area retarded recovery of cotton growing, since they offered alternative means of livelihood to a large number of persons who had previously worked in the cotton fields. An influence of the same type is found in the diversification of crops, at least in limited areas. In the Piedmont there was some increase in tobacco production and, more important, in the Coastal Plain there was a

shift to production of truck crops, potatoes, peanuts, and various other minor crops.

In the Delta Area a large acreage of rich, river-bottom land was available for clearing and draining. In response to the efforts of farmers to enlarge old farms and to create new ones out of the swamps, the acreage of cotton on land in the river-bottom counties doubled between 1907-11 and 1927-31. There was growth also in the Western Hilly Section, but it was at a slower rate.

The Western Cotton Area, which saw the greatest increase, was likewise under the stimulus to develop new farms as well as to apply new and profitable methods of mechanization. In Texas the Piney Woods, the Black Waxy and Gulf Coast Prairies, and the Western Semiarid Sections all saw pronounced expansion, with the latter section experiencing its most rapid growth during the 1920's.

As has been pointed out previously, mechanization played an increasing part in Texas as cotton moved from east to west. With the low yields and low quality of the cotton in the semiarid section, probably very little would have been grown there without the larger equipment drawn first by large teams of horses and later by tractors. Even with cotton of poorer quality than in the eastern areas, the advantage of nearly one-third in number of hours per bale promised enough remuneration to cause an increase of nearly 150 percent in acreage in the semiarid section between the end of the war and the period 1927-31.

Total Labor Used on Cotton

In the period 1933-36 an average of about 2.5 billion hours of labor was used annually in producing cotton in the United States, as shown in table 29. This estimate is about 850 million hours or 25 percent below that for the period 1907-11 and about 1 billion hours below that for the 1927-31 period (before acreage was reduced by the Agricultural Adjustment Administration cotton-control plans). There was a reduction in acreage of about 30 percent between the periods 1927-31 and 1933-36 in all areas except the Irrigated, where the reduction amounted to only 3.5 percent.

In the Eastern Area an estimated 716 million man-hours were spent annually in 1933-36 as compared to 974 million hours in

the preceding 5-year period. This latter figure represented a decline of nearly 400 million hours from 1907-11.

In the Delta Area there was an increase in total man-hours on this crop of about 25 percent from 1907-11 to 1927-31. The acreage in cotton, however, had risen 38 percent in the same time. The reduction in the next 5 years carried labor requirements slightly below the level from which they started.

In the Western Cotton Area the acreage in cotton expanded 61 percent from the earliest period given to 1927-31, while the amount of labor used in growing it increased only 24 percent, i. e., to 1,072 million hours. In the next 5 years the estimated labor dropped 37 percent to 673 million man-hours.

In short, the cotton acreage of the whole country increased 29 percent from 1907-11 to the 1927-31 period, while production rose 19 percent, and in the same interval the total number of man-hours used in growing the crop increased only 5 percent. By the 1933-36 period, however, acreage had dropped 31 percent from the 1927-31 level, production had fallen 22 percent, and the amount of labor required by the crop had decreased 29 percent.

PROSPECTS FOR EMPLOYMENT IN THE PRODUCTION OF COTTON

In view of the preceding discussion, what are the prospects for future employment in the production of cotton? It has been shown that in the Delta and in the Western Areas the amount of labor used in producing this crop increased about a quarter from the period 1907-11 to 1927-31 while there was a decline of slightly over a quarter in the Eastern Area. The net change for the country as a whole amounted to an increase of 5 percent. It is significant that where the declines took place, they occurred between 1916 and 1929 when opportunities for employment in other industries in those areas were greatest.⁷ The sharp drop since 1932 has been attributable largely to the AAA cotton-control program and cannot be taken to indicate a permanent level of production or of employment. There is a clear tendency toward a shrinking labor requirement per unit of production. During the years prior to 1932, however, the total labor used by the cotton crop remained quite constant because of increasing production.

⁷A report of E. E. Shaw and J. A. Hopkins on Trends in Employment in Agriculture, 1909-36 (WPA National Research Project, in preparation) deals more specifically with trends in agricultural employment.

It has been shown that the process of mechanization, although rapid in the Western Semiarid Section and pronounced in the Black Waxy and Delta Sections, has lagged behind greatly in sections which are hilly or are composed of small farms. The barriers to mechanization in such places are very difficult to overcome, but the very fact that other areas have made so much progress in reducing labor requirements and costs means added competitive pressure on the farmer of the Eastern Cotton Belt either to follow in the same path or to shift from cotton production into some other employment. The fact should be emphasized that cotton growers cannot simply stop growing cotton because it yields a low return. They must find some other enterprise which pays better.

It is often said that the position of the eastern cotton producer is made more difficult because of competition by western growers. This must not, however, be taken to mean that there is a demand for only a certain amount of cotton and that, if more is produced by one set of growers, less is left to be produced by others. In the past there has been no definite or limited size of crop to be grown. As we have seen, widely differing amounts of cotton have been produced and consumed during the last three decades, but at a considerable range of cotton values. The increased cotton production in western areas and in other countries threw more cotton on the market and thereby lowered the price. That also lowered the total income of any grower who was not able to reduce his costs as much as the drop in price. Thus the greater production in western areas and in other countries has not directly or necessarily forced eastern producers out of business or reduced the extent to which they were employed, using that term in the broad sense. It has, however, forced on them a lower level of income. This may even have increased the amount they worked, since it meant that they had to raise more cotton if they were to obtain the same income.

Mechanization and other technological improvements offer an avenue of escape to those farmers who are able to take advantage of them. Insofar as they can produce more cotton with the same labor, they may be able to maintain their income even at the lower cotton price. It has been shown, however, that there are limited opportunities for mechanization in many cotton areas. The individual cotton grower is likely to have but little direct consciousness of competition between areas. He is aware only

that cotton prices are dishearteningly low, that he must try to do more of the work himself to avoid paying out money for wages, and that he must deny himself and his family anything but the strict necessities of life if he is to get along at all. The typical tenant or cropper family (which produces little besides cotton), has less to spend for itself than half of the proceeds from 6 to 8 bales of cotton, worth \$40 to \$60 per bale, plus the proceeds from 6000 or 7000 pounds of cottonseed worth perhaps \$30 per ton. The small-owner family is not always or necessarily better off. It is not necessary to dwell on these shockingly low incomes. Families have "lived" on such incomes when they had to.⁸ But if they can they seek other lines of employment.

What are some of the alternative lines of activity for a part of the farm population in sections which are under the greatest disadvantages in cotton production? There has already been considerable shifting into vegetable crops, fruits, peanuts, hogs, and other farming enterprises in some areas. This shifting, however, is slow, with the opportunities far less than the need. Poor as it is, cotton remains for many the best agricultural alternative available in the Cotton Belt. Do other industries have more to offer? It would seem so, judging from the rapid movement of industries into this area during the past 15 or 20 years. The shift of industries to the South could ameliorate the effects of farm labor displacement by providing industrial opportunities for employment.

There are about 2 million cotton farms with a total population of something like 9 million persons. A great amount of labor could be shifted to other industries before the increase in the size of cotton farms and the increase in the price of cotton would raise the income of the average cotton producer either to the level of farm incomes in the North or to that of industrial incomes. It has been estimated that, in the course of 5 to 10 years, a successful mechanical picker might release upward of a half-million workers during the picking season.⁹ With the use of larger equipment, already available, in preparing the seedbed and cultivating the crop, there would be only the need for labor in chopping and hoeing to prevent the release of this number of

⁸See *Report to the President on the Economic Conditions of the South* (National Emergency Council, July 1938) for a statement of some of the effects of such an existence.

⁹R. L. Horne and E. G. McKibben, *Changes in Farm Power and Equipment: Mechanical Cotton Picker* (WPA National Research Project, Report No. A-2, Aug. 1937) pp. 18-22.

persons for the entire season. Such figures are, of course, largely hypothetical and are based on the assumption of the development of satisfactory new equipment. If such a development should occur, however, the rougher sections and the smaller farms would still be left to continue the slow and painful shift of part of their population into other industries, while the remainder applied available technological improvements on the more productive land.

The probable amount of such a shift in employment is very difficult to estimate. There are many sections even in the Delta and Western Areas where any large degree of mechanization is improbable, and this is even more true of most of the Eastern Cotton Area. Nevertheless, there was a decline, according to our estimates, of slightly over one-fourth in the total amount of labor used to raise cotton in the Eastern Area from 1907-11 to 1927-31. The decline in farm population here amounted to only about one-eighth and took place chiefly after 1920 until it was stopped by the depression after 1930. It seems likely that, should opportunities for employment become available elsewhere, a further shift in population fully as great will occur.

In the last analysis, therefore, employment in the production of cotton depends not only on the progress of mechanization, but also to a large degree on alternative employment in other industries. It is clear that employment in cotton production is not likely to increase, and it seems probable that there would be considerable shrinkage in the next 10 years if present cotton croppers and tenants could find other employment.

APPENDIXES

Appendix	Page
A: ACREAGE, YIELD, AND PRODUCTION OF COTTON IN THE UNITED STATES, 1909-36	114
B: CULTURAL PRACTICES FOLLOWED ON FARMS SURVEYED, 1909-36.	118
C: HOURS OF LABOR USED PER ACRE ON FARMS SURVEYED, 1909-36. /	118
D: VARIETIES OF COTTON, STAPLE LENGTH, AND APPLICATION OF FERTILIZER.	120
E: TOTAL LABOR USED IN PRODUCING COTTON IN THE UNITED STATES.	124
F: ABSTRACT OF DATA FROM SECONDARY SOURCES, LABOR ON COTTON.	128

Table A-1.- COTTON, ACREAGE HARVESTED, 1909-36^a
(Thousands of acres)

Year	U.S. total	East. Cotton Area	Delta Cotton Area	West. Cotton Area	Middle East. Area ^b	Range Area ^c	California
1909	30,555	10,275	6,119	11,874	1,939	*	-
1910	31,508	10,399	6,167	12,536	2,006	*	8
1911	34,916	11,380	6,399	14,317	2,347	*	12
1912	32,557	10,652	5,680	13,721	2,154	*	9
1913	35,206	10,656	6,341	15,594	2,235	*	28
1914	35,615	11,575	6,449	14,870	2,260	n.a.	38
1915	29,951	9,894	5,402	12,391	1,919	5 ^d	12
1916	33,071	10,196	6,603	13,482	2,338	15 ^d	60
1917	32,245	9,152	6,180	14,121	2,324	41	78
1918	35,038	10,173	7,002	15,022	2,330	95	78
1919	32,906	9,931	6,647	13,752	2,155	106	85
1920	34,408	9,379	6,776	15,370	2,245	230	150
1921	28,678	7,772	5,841	12,776	1,964	90	55
1922	31,361	7,144	6,548	14,794	2,340	130	67
1923	35,550	7,303	6,924	17,985	2,604	191	83
1924	39,501	7,663	7,194	20,852	2,770	285	129
1925	44,386	8,869	8,730	22,624	3,044	267	172
1926	44,608	9,302	8,910	22,360	2,989	278	162
1927	38,342	8,242	7,500	19,290	2,541	228	128
1928	42,434	8,762	9,016	20,894	2,739	326	218
1929	43,232	8,906	9,412	20,989	2,767	353	309
1930	42,444	8,959	9,593	20,067	2,667	338	270
1931	38,704	8,124	9,111	18,130	2,326	301	192
1932	35,891	7,328	8,854	16,442	2,384	225	123
1933	29,383	5,859	6,662	13,939	2,019	235	208
1934	26,866	5,561	5,886	12,744	1,786	226	223
1935	27,335	5,760	6,002	12,975	1,718	250	218
1936	30,054	6,020	6,905	14,124	1,821	325	368

^aCompiled from data obtained from the Bureau of Agricultural Economics, U. S. Department of Agriculture; see R. G. Bressler, Jr. and J. A. Hopkins, *Trends in Size and Production of the Aggregate Farm Enterprise, 1908-36* (Works Progress Administration, National Research Project, Report No. A-8, July 1938)

^bVirginia, North Carolina, and Tennessee.

^cNew Mexico and Arizona only States reporting cotton.

^dRounded off from consideration of miscellaneous States' figures.

*Less than 500 acres.

n.a. Data not available.

Table A-2.- COTTON, YIELD PER ACRE, 1909-36^a

(Pounds of lint)

Year	U.S. total	East. Cotton Area	Delta Cotton Area	West. Cotton Area	Middle East. Area ^b	Range Area ^c	Cali- fornia
1909	156	183	160	124	212	#	-
1910	176	140	180	151	251	#	358
1911	215	258	189	176	317	#	390
1912	201	193	186	206	259	#	465
1913	192	233	213	147	256	#	331
1914	216	248	201	188	283	n. a.	341
1915	178	196	187	149	254	268 ^d	348
1916	166	154	173	161	218	268 ^d	329
1917	167	190	195	138	180	268 ^e	228
1918	164	211	191	104	257	267 ^e	287
1919	166	183	154	143	258	270 ^e	262
1920	187	188	176	177	271	212 ^g	212
1921	132	130	154	100	266	239 ^g	226
1922	149	136	171	124	259	217 ^g	150
1923	136	127	110	133	238	270 ^g	313
1924	165	174	178	148	210	277 ^g	287
1925	174	184	246	124	262	331 ^g	339
1926	193	205	229	158	274	339 ^g	387
1927	162	175	185	134	235	340 ^g	340
1928	163	156	181	144	228	348 ^g	378
1929	164	188	212	116	226	329 ^g	400
1930	157	217	152	116	214	361 ^g	468
1931	212	224	239	174	286	343 ^g	440
1932	174	164	168	162	235	300 ^g	503
1933	213	229	192	195	276	386 ^g	500
1934	172	223	203	102	287	438 ^g	556
1935	186	238	212	130	256	402 ^g	524
1936	197	242	275	109	283	412 ^g	572

^aCompiled from data obtained from the Bureau of Agricultural Economics, U. S. Department of Agriculture; see R. G. Bressler, Jr. and J. A. Hopkins, *Trends in Size and Production of the Aggregate Farm Enterprise, 1909-36* (Works Progress Administration, National Research Project, Report No. A-R, July 1938).

^bVirginia, North Carolina, and Tennessee.

^cNew Mexico and Arizona only States reporting cotton.

^dAverage of 1917, 1918, and 1919.

^eCalculated from acreage and lint production.

^fBase too small for calculation.

^gn. a. Data not available.

Table A-3.- COTTON, LINT PRODUCTION, 1909-36^a
(Thousands of 500-pound bales)

Year	U.S. total	East. Cotton Area	Delta Cotton Area	West. Cotton Area	Middle East. Area ^b	Range Area ^c	California
1909	10,005	3,927	2,049	3,068	858	#	-
1910	11,609	4,124	2,330	3,972	1,053	#	6
1911	15,694	6,133	2,528	5,278	1,556	#	10
1912	13,703	4,299	2,214	5,901	1,167	#	8
1913	14,153	5,188	2,828	4,785	1,195	#	19
1914	16,112	6,000	2,711	5,854	1,340	n. a.	27
1915	11,172	4,061	2,111	3,867	1,018	3 ^d	9
1916	11,448	3,283	2,389	4,550	1,064	8 ^d	41
1917	11,284	3,636	2,519	4,084	877	23	37
1918	12,018	4,491	2,801	3,274	1,253	53	47
1919	11,411	3,796	2,143	4,115	1,163	60	47
1920	13,429	3,699	2,497	5,681	1,271	102	67
1921	7,945	2,121	1,889	2,679	1,094	45	26
1922	9,755	2,028	2,344	3,849	1,270	59	21
1923	10,140	1,943	1,594	4,996	1,296	108	54
1924	13,630	2,795	2,686	6,460	1,219	165	77
1925	16,105	3,405	4,501	5,854	1,670	185	122
1926	17,978	3,998	4,262	7,401	1,715	197	131
1927	12,956	3,020	2,901	5,389	1,251	162	91
1928	14,477	2,861	3,409	6,310	1,309	237	172
1929	14,825	3,509	4,165	5,083	1,309	243	259
1930	13,932	4,060	3,049	4,891	1,195	255	264
1931	17,097	3,812	4,558	6,581	1,393	216	177
1932	13,003	2,516	3,111	5,584	1,174	141	129
1933	13,049	2,809	2,680	5,694	1,165	190	217
1934	9,636	2,595	2,496	2,722	1,072	207	259
1935	10,638	2,862	2,668	3,523	919	210	239
1936	12,407	3,050	3,968	3,235	1,077	280	440

^aCompiled from data obtained from the Bureau of Agricultural Economics, U. S. Department of Agriculture; see R. O. Bressler, Jr. and J. A. Hopkins, *Trends in Size and Production of the Aggregate Farm Enterprise, 1909-36* (Works Progress Administration, National Research Project, Report No. A-6, July 1938).

^bVirginia, North Carolina, and Tennessee.

^cNew Mexico and Arizona only States reporting cotton.

^dRounded off from consideration of miscellaneous States figures.

^eBase too small for calculation.

n. a.-Data not available.

Table A-4.-- NUMBER OF FARMS SURVEYED AND ACREAGE PER FARM IN ALL CROPS AND IN COTTON, BY COUNTIES, 1909-36*

Section, county, and State	1909			1919			1929			1936		
	Number of farms surveyed	Acreage per farm		Number of farms surveyed	Acreage per farm		Number of farms surveyed	Acreage per farm		Number of farms surveyed	Acreage per farm	
		All crops	Cotton		All crops	Cotton		All crops	Cotton		All crops	Cotton
Coastal Plain	169	87	36	214	100	41	311	85	32	311	80	22
Sumter, Ga.	37	116	51	46	140	60	76	98	34	76	89	21
Brooks, Ga.	43	98	30	54	104	29	75	86	22	75	83	17
Darlington, S. C.	41	71	30	61	81	35	82	72	28	82	69	19
Madison, Miss.	48	67	36	53	84	44	78	86	43	78	80	31
Piedmont	89	57	27	114	59	27	156	54	23	156	46	14
Tallapoosa, Ala.	39	47	23	56	50	23	76	43	18	76	40	13
Greene, Ga.	50	65	30	58	67	31	80	65	27	80	52	15
Eastern Hilly												
Marshall, Ala.	42	40	16	51	42	19	80	44	20	80	38	14
Western Hilly												
White, Ark.	81	64	38	102	78	44	161	73	42	161	64	30
Rusk, Tex.	38	47	25	49	70	39	80	63	33	80	57	25
	43	79	50	53	86	49	81	84	50	81	72	35
Mississippi Delta												
Washington and Bolivar, Miss.	35	174	114	40	203	134	76	247	156	76	271	148
Texas Black Waxy Prairie												
Ellis, Tex.	41	152	76	47	156	83	80	145	84	80	146	73
Western Semiarid												
Lubbock, Tex.	26	132	49	99	159	68	162	200	114	162	200	98
Tillman, Okla.	4	114	41	44	141	66	87	209	120	87	205	110
	22	135	50	55	174	70	75	190	107	75	195	83

*Data obtained in NRP Farm Survey, 1936. See table 5 for major topography and soil type of each county.

APPENDIX B
CULTURAL PRACTICES FOLLOWED ON FARMS
SURVEYED, 1909-36

and

APPENDIX C
HOURS OF LABOR USED PER ACRE ON FARMS
SURVEYED, 1909-36

These appendixes consist of 37 pages of statistical material summarizing by counties and for the years 1909, 1919, 1929, and 1936 the information indicated in the above titles. The data were obtained in the 1936 field study of the WPA National Research Project and are based on the memory of the farmers interviewed. Since these detailed statistics are of interest to relatively few readers of this report, they are not included here. Two typed copies were bound separately and were deposited in the Library of the Bureau of Agricultural Economics of the United States Department of Agriculture at Washington, D. C.

A list of the tables included in these appendixes follows:

APPENDIX B

Table

- B-1. Number of schedules obtained, acreages of cotton and of all crops on farms surveyed, for specified years, 1909-36¹
- B-2. Percentage of farmers following specified preharvest cultural practices in producing cotton, 1909-36²
- B-3. Percentage of farmers following specified harvesting practices, 1909-36²
- B-4. Cultural practices in the production of cotton, 1909-36³
- B-5. Average amounts of fertilizer, side dressing, and manure applied per acre on farms reporting, 1909-36

¹Same data as in table A-4.

²Tabulated by methods used and number of times performed.

³The table presents the average number of times (average of all farms surveyed) each operation was performed.

APPENDIX C

Table

- C-1. Hours of labor used per acre preceding harvest by operations, 1909-36
- C-2. Estimates of labor used in harvesting cotton by operations, with yield per acre and amount picked per worker per day, 1909-36
- C-3. Labor used in producing cotton, 1909-36⁴

⁴Presented as total amount of labor per acre with subtotals of preharvest and harvest labor.

Table D-1.- PERCENTAGE DISTRIBUTION OF FARMS REPORTING RECOGNIZED VARIETIES BY PRINCIPAL VARIETY REPORTED IN THE THREE MAJOR COTTON AREAS, 1909-36^a

Variety	Percent of farmers reporting in -											
	Eastern Area				Delta Area				Western Area			
	1909	1919	1929	1936	1909	1919	1929	1936	1909	1919	1929	1936
All varieties	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Improved varieties ^b	72.9	84.3	86.8	90.5	69.7	78.1	91.1	92.9	89.9	81.4	58.1	56.2
Cleveland and Cleveland Big Boll	47.0	36.2	14.8	6.9	24.4	10.2	1.4	0.4	0	0	0	0
Cook	5.1	8.4	8.7	8.3	0	0	0	0	0	0	0	0
Petty's Toole	5.1	5.8	8.8	7.0	0	0	0	0	0	0	0	0
Toole	2.9	6.6	11.0	9.3	0	0	0	0	0	0	0	0
Rucker	3.5	7.5	13.2	8.2	0	0	0	0	0	0	0	0
D. and P. L.	4.0	5.4	9.4	13.1	0	1.7	9.9	21.3	0	0	0	0
Coker	0.6	3.4	9.7	7.7	2.4	7.5	4.2	0.9	0	0	0	0
Lightning Express	1.2	2.0	4.2	3.5	4.6	5.8	0.4	0.4	0	0	0	0
Stoneville	0	0.4	1.4	4.0	0	0	1.0	2.8	0	0	0	0
Wilds	0	1.2	2.6	5.0	0	0	2.9	2.8	0	0	0	0
Foster	0	0.4	1.2	2.3	1.1	4.2	2.3	0.9	0	0	0	0
Farm Relief	0	0	0.5	10.3	0	0	1.0	10.4	0	0	0	0
Rowden	0	0	0	0	23.2	17.7	10.4	5.4	29.2	8.2	1.2	0.6
Half and Half	3.5	5.0	3.3	2.9	7.0	14.3	11.4	10.4	2.5 ^c	12.5 ^c	19.4 ^c	21.7 ^c

Delfos	0	0	0	0	2.4	7.5	19.8	15.9	0	0	0	0
Missdel	0	0	0	0	0	1.7	17.4	15.4	0	0	0	0
Acala	0	0	0	0	1.1	4.2	8.1	4.1	0	2.8	4.8	2.9
Mebane and strains	0	0	0	0	3.5	3.3	0.9	1.8	47.2	43.2	22.1	20.0
Bennett and Lone Star	0	0	0	0	0	0	0	0	5.6	6.0	0.3	0.3
Kasch	0	0	0	0	0	0	0	0	2.3	5.0	3.9	1.2
Lankhart	0	0	0	0	0	0	0	0	1.1	1.1	0.9	3.5
Bryant Mebane	0	0	0	0	0	0	0	0	1.1	1.7	2.3	2.9
Qualla	0	0	0	0	0	0	0	0	0	0	0.9	1.9
Watson	0	0	0	0	0	0	0	0	1.1	1.1	2.3	1.2
Unimproved varieties	17.8	5.3	1.6	0.2	20.9	9.2	1.4	0	7.9	18.0	41.6	43.8
Peterkin	7.6	0.8	0.2	0	0	0	0	0	0	0	0	0
King and King improved	5.1	2.0	0.4	0	11.6	8.4	1.0	0	0	0	0	0
Poulnott	5.1	2.5	1.0	0.2	0	0	0	0	0	0	0	0
Black Rattler	0	0	0	0	9.3	0.8	0.4	0	0	0	0	0
Half and Half	0	0	0	0	0	0	0	0	7.9 ^d	18.0 ^d	41.6 ^d	43.8 ^d
Other varieties	9.3	10.4	11.6	9.3	9.4	12.7	7.5	7.1	2.2	0.6	0.3	0

^aData obtained in NRP Farm Survey, 1936.

^cHalf and Half as reported in Oklahoma.

^bImproved varieties classified on basis of State report as published. J. O. Ware, Extent of Improved Varieties of Cotton in the United States (U. S. Dept. Agr. Leaflet, mimeo., 1937).

^dHalf and Half as reported in Texas where not considered as improved.

Table D-2.- AVERAGE STAPLE LENGTH OF AMERICAN UPLAND COTTON IN THE UNITED STATES AND IN THE THREE MAJOR COTTON AREAS, 1928-36^a

Year	United States		Eastern Area		Delta Area		Western Area	
	Six- teenths of an inch	Inches	Six- teenths of an inch	Inches	Six- teenths of an inch	Inches	Six- teenths of an inch	Inches
1928	15.18	0.949	14.64	0.915	15.95	0.997	15.01	0.938
1929	15.11	.944	14.43	.902	15.95	0.997	14.80	.925
1930	15.22	.951	14.66	.916	15.94	0.996	15.10	.944
1931	15.44	.965	14.89	.931	16.38	1.024	15.05	.941
1932	15.45	.966	15.04	.940	16.41	1.026	14.96	.935
1933	15.55	.972	14.99	.937	16.74	1.046	15.18	.949
1934	15.58	.974	15.17	.948	16.60	1.038	14.74	.921
1935	15.47	.967	15.10	.944	16.42	1.026	14.84	.928
1936	15.78	.986	15.49	.968	16.56	1.035	14.76	.922

^aData for: 1928-33 obtained or derived from Grade, Staple Length, and Tenderability of Cotton in the United States, 1928-29 to 1933-34 (U. S. Dept. Agr. Statistical Bull. No. 52, 1936), pp. 17-22; 1934 from same for 1928-29 to 1934-35 (Statistical Bull. No. 56, 1937), pp. 21-3; 1935 from same for 1928-29 to 1935-36 (Statistical Bull. No. 60, 1937), pp. 17-9; 1936 from same for 1928-29 to 1936-37 (mimeo., July 1937), pp. 22-3.

Table D-3.- TENDERABILITY OF AMERICAN UPLAND COTTON GINNED IN THE UNITED STATES AND IN THE THREE MAJOR COTTON AREAS, 1928-36^a

(Tenderable cotton^b as a percentage of all cotton)

Year	United States	Eastern Area	Delta Area	Western Area
1928	81.8	83.1	87.2	79.9
1929	75.7	69.4	89.1	69.3
1930	84.6	78.0	90.3	85.1
1931	89.3	94.2	92.7	85.5
1932	90.5	92.0	95.7	87.5
1933	93.1	93.6	98.3	90.8
1934	90.1	90.6	95.3	83.4
1935	80.2	81.0	94.6	69.6
1936	87.0	95.4	94.2	70.6

^aData for: 1928-33 from Grade, Staple Length, and Tenderability of Cotton in the United States, 1928-29 to 1933-34 (U. S. Dept. Agr. Statistical Bull. No. 52, 1936), pp. 115-6; 1934 from same for 1928-29 to 1934-35 (Statistical Bull. No. 56, 1937), pp. 55-6; 1935 and 1936 from same for crop of 1936 (prelim. release, mimeo., Apr. 1937).

^bTenderable in settlement of future contracts. In general, tenderable cotton includes all except cotton shorter than 7/8 inch in staple, regardless of grade, and cotton of certain of the lower grades in the various color groups irrespective of staple length.

Table D-4.- TONS OF FERTILIZER CONSUMED IN THE THREE MAJOR COTTON AREAS AND PRICE OF COTTON, 1909-35

Year	Fertilizer consumed (thousands of tons) ^a				Price of cotton (cents per pound) ^b
	Total	Eastern Area	Delta Area	Western Area	
1909	n.a.	n.a.	n.a.	n.a.	13.60
1910	2,708	2,422	251	35	13.95
1911	3,025	2,692	279	54	9.60
1912	2,746	2,442	245	59	11.49
1913	2,670	2,314	279	77	12.51
1914	3,352	2,970	303	79	7.36
1915	2,051	1,846	185	20	11.22
1916	2,062	1,781	238	43	17.33
1917	2,234	1,957	233	44	27.12
1918	2,613	2,278	274	61	28.92
1919	2,645	2,323	272	50	35.41
1920	2,855	2,477	319	59	15.92
1921	1,447	1,303	120	24	17.01
1922	1,623	1,333	254	36	22.87
1923	2,292	1,817	393	82	28.69
1924	2,540	1,980	428	132	22.91
1925	2,848	2,250	492	106	19.59
1926	2,885	2,236	519	130	12.47
1927	2,390	1,918	387	85	20.19
1928	3,109	2,353	603	153	17.99
1929	3,169	2,304	659	206	16.79
1930	3,211	2,322	737	152	9.46
1931	2,131	1,705	354	72	5.66
1932	1,197	1,009	151	37	6.52
1933	1,509	1,285	188	36	10.17
1934	1,821	1,480	280	61	12.36
1935	2,068	1,653	346	69	11.09

^aData obtained from National Fertilizer Association and U. S. Department of Agriculture, Bureau of Chemistry and Soils.

^bAgricultural Statistics, 1937 (U. S. Dept. Agr., 1937), pp. 88-9.

n.a.—Data not available.

Table E-1.- LABOR USED IN PRODUCING COTTON IN THE UNITED STATES

Yearly Averages for 1907-11 to 1933-36, by States

Cotton-producing area and State	Thousands of acres ^a		Millions of man-hours on -			Hours per harvested acre on ^b -		Production (thousands of bales) ^a	Hours per bale produced for ^c -	
	Harvested	Abandoned	Total acreage	Harvested acreage	Abandoned acreage	Harvested acreage	Total acreage ^d		Harvested crop	Total crop ^d
1907-11										
United States	31,759	808	3,343	3,321	24	105	105	12,332	269	271
Eastern	10,483	216	1,358	1,349	8	129	130	4,536	297	299
South Carolina	2,358	43	346	344	2	146	147	1,241	277	279
Georgia	4,614	108	595	591	4	128	129	2,017	293	295
Alabama	3,511	65	417	414	2	118	119	1,278	324	326
Delta	6,480	209	793	786	8	121	122	2,597	303	305
Mississippi	3,367	94	421	418	3	124	125	1,335	313	315
Louisiana	1,133	42	140	138	2	122	123	406	340	344
Arkansas	1,980	73	232	230	3	116	117	856	268	271
Western	12,374	333	863	858	6	69	70	3,997	215	216
Texas	10,002	241	684	680	4	68	68	3,188	213	214
Oklahoma	2,372	92	179	178	2	75	76	809	220	222
Middle Eastern ^e	2,041	37	285	284	1	139	140	1,072	265	266
Irrigated Area ^f	4	*	*	*	*	122	122	3	163	163
All other States ^g	377	13	43	43	*	114	114	127	339	339

1917-21

United States	32,655	1,215	3,089	3,062	27	94	95	11,219	273	275
Eastern	9,282	203	1,115	1,109	7	119	120	3,550	312	314
South Carolina	2,532	36	361	360	1	142	146	1,322	272	273
Georgia	4,408	112	806	803	4	114	115	1,575	319	322
Alabama	2,342	55	248	246	2	105	106	653	377	379
Delta	6,489	194	738	731	6	113	114	2,369	309	312
Mississippi	2,755	85	317	314	3	114	115	960	327	330
Louisiana	1,250	40	148	146	1	117	118	438	334	337
Arkansas	2,484	69	273	271	2	109	110	971	279	281
Western	14,208	758	883	872	11	61	62	3,967	220	223
Texas	11,421	564	693	685	8	60	61	3,093	222	224
Oklahoma	2,787	194	190	187	3	67	68	874	214	217
Middle Eastern ^g	2,204	41	301	299	2	136	137	1,132	264	266
Irrigated Area ^f	201	7	22	22	*	109	109	102	216	216
All other States ^h	271	12	30	29	*	107	111	99	293	303

See footnotes at end of table.

Table E-1.- LABOR USED IN PRODUCING COTTON IN THE UNITED STATES - Continued

Yearly Averages for 1907-11 to 1933-36, by States

Cotton-producing area and State	Thousands of acres ^a		Millions of man-hours on -			Hours per harvested acre on ^b -		Production (thousands of bales) ^a	Hours per bale produced for ^c -	
	Harvested	Abandoned	Total acreage	Harvested acreage	Abandoned acreage	Harvested acreage	Total acreage ^d		Harvested crop	Total crop ^d
1927-31										
United States	41,031	988	3,493	3,474	18	85	85	14,658	237	238
Eastern	8,598	148	974	969	5	113	113	3,452	281	282
South Carolina	1,955	46	244	242	2	124	125	858	283	285
Georgia	3,245	59	362	360	2	111	112	1,291	279	281
Alabama	3,398	43	368	367	1	108	108	1,303	282	283
Delta	8,927	150	982	978	5	110	110	3,615	271	272
Mississippi	3,875	50	439	438	2	113	113	1,594	275	276
Louisiana	1,799	28	206	205	1	114	115	733	280	281
Arkansas	3,253	72	337	335	2	103	104	1,288	260	262
Western	19,875	631	1,072	1,065	7	54	54	5,651	188	190
Texas	16,070	484	857	852	5	53	53	4,551	187	188
Oklahoma	3,805	147	215	213	2	56	56	1,100	194	195
Middle Eastern ^e	2,608	36	345	343	1	132	132	1,291	266	267
Irrigated Area ^f	532	10	63	63	*	118	118	416	151	151
All other States ^g	491	13	57	56	*	114	116	233	240	245

1933-36

United States	28,410	3,321	2,489	2,433	62	86	88	11,432	213	218
Eastern	5,800	525	716	699	17	121	123	2,832	247	253
South Carolina	1,357	117	183	179	4	132	135	744	241	246
Georgia	2,185	192	266	260	6	119	122	1,056	246	252
Alabama	2,258	216	267	260	7	115	118	1,032	252	259
Delta	6,354	647	739	721	21	113	116	2,955	244	250
Mississippi	2,742	255	339	332	8	121	124	1,368	243	248
Louisiana	1,271	126	147	144	4	113	116	570	252	259
Arkansas	2,351	266	253	245	9	104	108	1,017	240	249
Western	13,443	1,944	673	654	20	49	50	3,791	172	178
Texas	10,913	1,476	549	535	15	49	50	3,181	168	173
Oklahoma	2,530	468	124	119	5	47	49	610	195	202
Middle Eastern ^a	1,836	142	238	236	2	129	130	1,055	224	226
Irrigated Area ^f	513	23	65	65	1	127	127	515	126	126
All other States ^g	454	40	58	58	1	128	128	284	204	204

^aData from U. S. Department of Agriculture, Bureau of Agricultural Economics.

^bAverage hours per acre for States (marketing excluded) were calculated by weighting the hours per acre in sections within States, as obtained in the NRP Farm Survey and earlier studies, by the cotton acreage in each section, as reported for counties by the U. S. Census Bureau. The hours per acre for States were then weighted by 5-year average acreages to obtain average labor requirements in each of the areas and in the United States.

^cGross, includes bagging and ties.

^dHours per harvested acre (and per bale) adjusted to include labor spent on abandoned acreage.

^eNorth Carolina, Tennessee, and Virginia.

^fArizona, California, and New Mexico.

^gIllinois, Kansas, Kentucky, Missouri, and Florida.

^hLess than 0.5.

Table F-1.- ABSTRACT OF DATA FROM SECONDARY SOURCES, LABOR ON COTTON

County or section	Year of study	Number of records	Yield per acre, lint, pounds	Man-hours per acre			Source ^a
				Total	Preharvest	Harvest	
Alabama							
Chilton Co.	1923	51	134	111.1	79.7	31.4	USDA ^b
Dale Co.	1918	90	194	117	67	50	USDA Bull.1000,t.6,6
Lauderdale Co.	1919	84	192	120	69	51	USDA Bull.1000,t.6,6
Madison Co.	1923	52	110	101.9	70.1	31.8	USDA ^b
Marshall Co.	1918	90	227	127	76	61	USDA Bull.1000,t.6,6
Marshall Co.	1919	79	272	128	70	58	USDA Bull.1000,t.6,6
Marshall and De Kalb Cos.	1928-29	106	358	111.9	68.3	55.6	AES Bull.236,der.from t.18
State ^c	1918 ^d	n.a.	n.a.	121.9	69.4	62.6	Polytechnic Inst.Ext.Services Cir.33,p.44
Tallapoosa Co.	1918	69	172	124	65	39	USDA Bull.1000,t.6,6
Arizona							
Salt River Valley	1928-30	n.a.	n.a.	n.a.	25	n.a.	AES Bull.146,t.1,3,4,7,9
Acala ^e	1928	(f)	420	35-39 ^h	32-36 ^h	3 ^h	Ext.Cir.60,p.6; t.1,2
Short, staple ^e	1928	n.a.	495	n.a.	22.9	n.a.	AES Bull.139,t.I-III
Upland; short, staple ^e	1929	51	467	n.a.	19.3	n.a.	AES Bull.146,t.1,3,4,7,9
Upland; short, staple ^e	1930	38	474	n.a.	19.5	n.a.	AES Bull.146,t.1,3,4,7,9
Pima ^e	1928	n.a.	379.5	n.a.	27.5	n.a.	AES Bull.139,t.I-III
Pima ^e	1928	(f)	320	40-44 ^h	37-41 ^h	3 ^h	Ext.Cir.60,p.6; t.1,2
Pima ^e	1929	58	311	n.a.	20.5	n.a.	AES Bull.146,t.1,3,4,7,9
Pima ^e	1930	29	348	n.a.	18.3	n.a.	AES Bull.146,t.1,3,4,7,9
Arkansas							
Chicot Co.	1920 ^d	n.a.	600 ⁱ	11.7 ^j	6.8 ^j	5.1 ^j	USDA Dept.Bull.1181,t.1; pp.10-2
Columbia Co.	1920 ^d	n.a.	600 ⁱ	9.4 ^j	4.4 ^j	5.1	USDA Dept.Bull.1181,t.1; pp.10-2
Crawford Co.	1920 ^d	n.a.	600 ⁱ	9.5 ^j	4.4 ^j	6.2	USDA Dept.Bull.1181,t.1; pp.10-2
Delta Cos. ^k							
56-42 inch rows							
Mules ^l	1929	94	n.a.	190.0	76.1	113.9	USDA Tech.Bull.497,t.15
Tractors ^l	1929	24	n.a.	117.5	40.7	76.8	USDA Tech.Bull.497,t.15
Mules and tractors ^l	1929	40	n.a.	173.1	64.6	108.5	USDA Tech.Bull.497,t.15
44-48 inch rows, mules ^l	1929	11	n.a.	188.7	90.1	98.6	USDA Tech.Bull.497,t.15

Faulkner Co.	1914	29	n.a.	9.8 ^j	n.a.	n.a.	USDA Dept. Bull. 1181, t. 1; pp. 10-2
Faulkner Co.	1923	53	114	84.2	67.0	27.2	USDA ^b
Lee Co.	1919	83	174	164	109	55	USDA Bull. 1000, t. 5, 6
Lee Co.	1923	52	64	83.4	67.3	26.1	USDA ^b
Mississippi Co.	1920 ^d	n.a.	600 ⁱ	11.9 ^j	6.8 ^j	5.1 ^j	USDA Dept. Bull. 1181, t. 1; pp. 10-2
Fulaski Co.	1920 ^d	n.a.	600 ⁱ	11.1 ^j	6.0 ^j	5.1 ^j	USDA Dept. Bull. 1181, t. 1; pp. 10-2
State	1922 ^d	n.a.	n.a.	112	n.a.	n.a.	USDA Dept. Bull. 1346, a-t, VIII
Florida							
Jackson Co.	1926	14	169	108.7	49.5	59.2	Univ. of Fla. ²
Georgia							
Brooks Co.	1914	143	299	13.9 ^j	n.a.	n.a.	USDA Bull. 646, p. 2; t. XVIII
Greene Co.	1918	78	260	131	74	57	USDA Bull. 1000, t. 5, 6
Greene Co.	1919	74	225	108	63	45	USDA Bull. 1000, t. 5, 6
Greene Co.	1923	50	163	130.1	90.2	39.9	USDA ^b
Laurens Co.	1918	85	277	125	61	64	USDA Bull. 1000, t. 5, 6
Laurens Co.	1919	77	93	78	55	23	USDA Bull. 1000, t. 5, 6
Limestone Valleys	1929	49	n.a.	99.7	41.5	56.3	AES Bull. 434, t. XVIII, XXIX
Mitchell Co.	1919	50	159	100	61	39	USDA Bull. 1000, t. 5, 6
Piedmont	1918 ^d	n.a.	n.a.	147.9	93.4	54.5	State Coll. ^a
Piedmont	1929	50	n.a.	126.9	56.9	70.0	AES Bull. 434, t. XVIII, XXIX
Southern Coastal Plains	1913-18 ^d	n.a.	n.a.	137.0	74.9	62.1	State Coll. ^c
Southern Coastal Plains	1921 ^d	249	n.a.	132.5	n.a.	n.a.	USDA Dept. Bull. 1292, t. 1
Southern Coastal Plains	1929	73	n.a.	99.9	49.0	51.0	AES Bull. 434, t. XVIII, XXIX
State	1922 ^d	n.a.	n.a.	125	n.a.	n.a.	USDA Dept. Bull. 1348, a-t, VIII
Sumter Co.	1918	80	244	136	61	65	USDA Bull. 1000, t. 5, 6
Sumter Co.	1923	51	93	112.8	82.6	30.2	USDA ^b
Louisiana							
Northwest	1918 ^d	191	n.a.	100.3	50.3	50.0	USDA Bull. 961, t. I, XVII
Sugarcane Area	1929	n.a.	n.a.	121.6	56.7	62.9	AES La. Bull. 215, a-t, 26

See footnotes at end of table.

Table P-1.- ABSTRACT OF DATA FROM SECONDARY SOURCES, LABOR ON COTTON - Continued

County or section	Year of study	Number of records	Yield per acre, lint, pounds	Man-hours per acre			Source ^a
				Total	Preharvest	Harvest	
Mississippi							
Bolivar Co.	1923	61	186	113.6	73.6	40.0	USDA ^b
Choctaw Co.	1924-26	39	206	105	60.9	44.1	AES Bull.257,t.8
Choctaw Co.	1925	17	214	104.6	56.9	47.6	AES Bull.237,t.3
Delta Cos.	1929	(p)	(p)	(p)	(p)	(p)	USDA Tech.Bull.497,t.15
Jones Co.	1927	19	298	121.1	61.7	69.4	AES Bull.276,t.7,8
Jones Co.	1928	15	123 ^q	100.3	72.0	28.3	AES Bull.276,t.7,8
Madison Co.	1923	62	131	141.4	93.0	48.4	USDA ^b
Monroe Co.	1919	49	132	88	54	34	USDA Bull.1000,t.5,6
Washington Co.	1919	29	171	141	87	54	USDA Bull.1000,t.6,6
New Mexico							
Curry and Roosevelt Cos. ^r	1924-28	125	60	10.6	3.0	7.5	AES Bull.187,p.6; fig.10; t.8
Elephant Butte Irrigation Project	1926-27	35	492	124.0	49.9	74.1	AES Ext.Cir.97,pp.5,10; t.3; fig.6
North Carolina							
East Central	1930-34	147	366	n.a.	45.6	n.a.	AES Bull.306,t.22,41-3
Johnson Co.	1923	64	436	154.0	66.7	65.3	USDA ^b
Johnson and Cumberland Cos.	1924	20	259	129.8	68.1	61.6	AES Bull.306,t.22,41-3
Northampton Co.	1927	20	407	114.2	59.3	54.9	AES Bull.306,t.22,41-3
Oklahoma							
Grady Co.	1923	51	139	49.4	25.3	24.1	USDA ^b
McIntosh Co.	1923	52	93	60.2	39.0	21.2	USDA ^b
Tillman Co.	1929	78	268	n.a.	6.0 ^q	n.a.	AES Bull.208,t.LI
Tillman Co.	1931	67	261	n.a.	5.0 ^q	n.a.	AES Bull.208,t.LI
Washita Co.	1929	70	241	n.a.	9.1 ^q	n.a.	AES Bull.208,t.LI

South Carolina							
Anderson Co.	1918	89	248	131	75	56	USDA Bull.1000,t.5,6
Anderson Co.	1919	74	286	140	80	60	USDA Bull.1000,t.5,6
Anderson Co.	1922	120	204	116	n.a.	n.a.	AES Bull.221,t.4,5
Anderson Area	1924	n.a.	265	118	n.a.	n.a.	AES Bull.230,t.18
Bamberg, Fairfax, and Williston Areas	1929-30	120	260	111.5	62.5	49.0	AES Cir.45,p.6; t.7,15
Barnwell Co.	1918	91	268	136	73	63	USDA Bull.1000,t.5,6
Barnwell Co.	1919	78	248	117	65	62	USDA Bull.1000,t.5,6
Darlington Co.	1923	61	229	142.6	78.0	64.6	USDA ^b
Lexington-Batesbury Area	1924	35	301	135	n.a.	n.a.	AES Bull.233,t.9
Fee Dee	1925-27	90	217 ^h	110	n.a.	n.a.	AES Bull.269,t.18; a-t.34
Piedmont	1927-28	52	290 ^h	113 ^h	n.a.	n.a.	AES Bull.264,t.9
Piedmont	1930	10	351	117.8	65.3	62.5	AES Cir.46,p.4; t.2; p.8; t.8
Southwestern Coastal Plains State	1929-32	250	n.a.	130	n.a.	n.a.	AES Bull.301,pp.5,62
Sumter Co.	1922 ^d	n.a.	n.a.	136	n.a.	n.a.	USDA Dept.Bull.1348,a-t,VIII
	1931-32	120	265	110	n.a.	n.a.	AES Bull.288,pp.6,7; t.22
Texas							
Black Waxy Prairie	1918 ^d	n.a.	n.a.	57	23	34	USDA Dept.Cir.163,fig.44
Corpus Christi							
Tractor	1926	9	n.a.	n.a.	10.3	n.a.	AES Bull.362,t.3
Horse	1926	12	n.a.	n.a.	14.2	n.a.	AES Bull.362,t.3
Tractor and horse.	1928	12	n.a.	n.a.	15.8	n.a.	AES Bull.362,t.3
Corpus Christi	1930	n.a.	n.a.	71.8	18.8	53.0	USDA Misc.Pub.157,t.3
Ellis Co.	1914	114	245	5.7 ^j	n.a.	n.a.	USDA Bull.659,p.1; t.XIV,XV
Ellis Co.	1918	75	176	56	31	26	USDA Bull.1000,t.5,6
Ellis Co.	1919	71	(v)	46	31	15	USDA Bull.1000,t.5,6
Ellis Co.	1923	60	173	54.1	27.7	26.4	USDA ^b
Lubbock Co.	1923	52	183	58.9	15.1	23.8	USDA ^b
Piney Woods	1925-29	27	135	76.5	50.0	26.5	AES Bull.463,p.7; fig.6; t.4
Rockwall and Collin Cos.	1925	23	208	67.8	27.1	40.7	AES Bull.395,t.17,18
Rockwall and Collin Cos.	1926	27	254	59.8	28.1	41.7	AES Bull.395,t.17,18
Rusk Co.	1918	75	185	86	49	37	USDA Bull.1000,t.5,6
Rusk Co.	1919	75	61	64	48	16	USDA Bull.1000,t.5,6
Rusk Co.	1923	55	171	74.8	45.2	29.6	USDA ^b

See footnotes at end of table.

Table F-1.- ABSTRACT OF DATA FROM SECONDARY SOURCES, LABOR ON COTTON - Continued

County or section	Year of study	Number of records	Yield per acre, lint, pounds	Man-hours per acre			Source ^a
				Total	Preharvest	Harvest	
Texas - Continued							
San Angelo							
Tractor	1926	9	n.a.	n.a.	9.8	n.a.	AES Bull.362,t.4
Horse	1926	21	n.a.	n.a.	14.8	n.a.	AES Bull.362,t.4
Tractor and horse	1926	11	n.a.	n.a.	8.8	n.a.	AES Bull.362,t.4
State	1841	n.a.	n.a.	148.6	80.6	68.0	USDA Misc.,Pub.157,t.3
State	1895	n.a.	n.a.	102.4	48.4	56.0	USDA Misc.,Pub.157,t.3
State	1922 ^d	n.a.	n.a.	64	n.a.	n.a.	USDA Dept.,Bull.1348,a-t,VIII

^aAbbreviations used are as follows: USDA, United States Department of Agriculture; AES, Agricultural Experiment Station; Agr., Agriculture; Inst., Institute; Ext., Extension; Dept., Department; Div., Division; Coll., College; Univ., University; Bull., Bulletin; Cir., Circular; Tech., Technical; Prelim., preliminary; mimeo., mimeographed; Misc., Miscellaneous; Pub., Publication; t., table(s); a-t., appendix table(s).

^bL. E. Long and C. R. Swinson, Cost of Producing Cotton in Fifteen Selected Areas (prelim. mimeo., July 1925), t. 1, p. 5.

^cApparently standards of performance.

^dApproximate date. In cases where the publications did not state what year data referred to, an approximate date is given - usually 4 years prior to date of publication.

^eType or variety of cotton.

^f175 records of Acala and Pima together in 1928.

^gExclusive of thinning and hoeing which was hired on contract at average cost of \$2.60 per acre. First figure represents cotton after cotton, hegari, or fall lettuce; second figure, after alfalfa.

^hExclusive of picking which was hired on contract for average of \$4.54 per 100 pounds of lint.

ⁱAssumed pounds of seed cotton per acre.

^jMan-days per acre.

^kData from 9 Delta counties in Arkansas and 10 in Mississippi.

^lFor power. Tractors are general-purpose.

^mColl. of Agr., Univ. record, Vol. XXII, No. 2, 1927, t. 1, 2.

ⁿExt. Div., Bull. 270, p. 33.

^oExt. Div., Bull. 275, t. 8.

^pSee "Delta Coe." under Arkansas.

^qUnfavorable season.

^rDry-land farming.

^sDoes not include chopping.

^tAverage for 369 farms.

^uAverage for the two groups given, "best" and "poorest" farms.

^v50 pounds per acre of picked cotton, 29 per acre of bolly cotton, and 24 per acre of unginned seed cotton.

^wn.a.=Data not available.

WPA NATIONAL RESEARCH PROJECT

Reports issued to date

General

The Research Program of the National Research Project
Unemployment and Increasing Productivity (*out of print*)
Summary of Findings to Date, March 1938

Studies in Changing Technology and Labor Productivity

Mining

- No. E-1 Technology and the Mineral Industries (*out of print*)
- No. E-2 Small-Scale Placer Mines as a Source of Gold, Employment, and Livelihood in 1935 (*out of print*)
- No. E-3 Mechanization Trends in Metal and Nonmetal Mining as Indicated by Sales of Underground Loading Equipment
- No. E-4 Employment and Related Statistics of Mines and Quarries, 1935: Coal
- No. E-5 Fuel Efficiency in Cement Manufacture, 1909-1935
- No. E-6 Mineral Technology and Output per Man Studies: Grade of Ore

Agriculture

- No. A-1 Changes in Technology and Labor Requirements in Crop Production: Sugar Beets
- No. A-2 Changes in Farm Power and Equipment: Mechanical Cotton Picker
- No. A-3 Selected References on Practices and Use of Labor on Farms (*in two parts*)
- No. A-4 Changes in Technology and Labor Requirements in Crop Production: Potatoes
- No. A-5 Changes in Technology and Labor Requirements in Crop Production: Corn
- No. A-6 Trends in Size and Production of the Aggregate Farm Enterprise, 1909-36
- No. A-7 Changes in Technology and Labor Requirements in Crop Production: Cotton (*in press*)

Manufacture

- No. M-1 Productivity and Employment in Selected Industries: Beet Sugar (*in press*)
- No. B-1 Labor Productivity in the Leather Industry (*Summary*)
- No. B-2 Mechanical Changes in the Cotton-Textile Industry, 1910 to 1936 (*Summary*)
- No. B-3 Mechanical Changes in the Woolen and Worsted Industries, 1910 to 1936 (*Summary*)
- No. B-4 Effects of Mechanization in Cigar Manufacture (*Summary*)
- No. B-5 Systems of Shop Management in the Cotton-Garment Industry (*Summary*)

Studies of the Effects of Industrial Change on Labor Markets

- No. P-1 Recent Trends in Employment and Unemployment in Philadelphia
- No. P-2 The Labor Force of the Philadelphia Radio Industry in 1936
- No. P-3 Employment and Unemployment in Philadelphia in 1936 and 1937 (*Part II in press*)
- No. P-4 Ten Years of Work Experience of Philadelphia Weavers and Loom Fixers
- No. P-5 Ten Years of Work Experience of Philadelphia Machinists
- No. L-1 Cigar Makers — After the Lay-Off

Requests for copies of these reports should be addressed to:
Publications Section, Division of Information
Work Progress Administration
Washington, D. C.