Chapter 7

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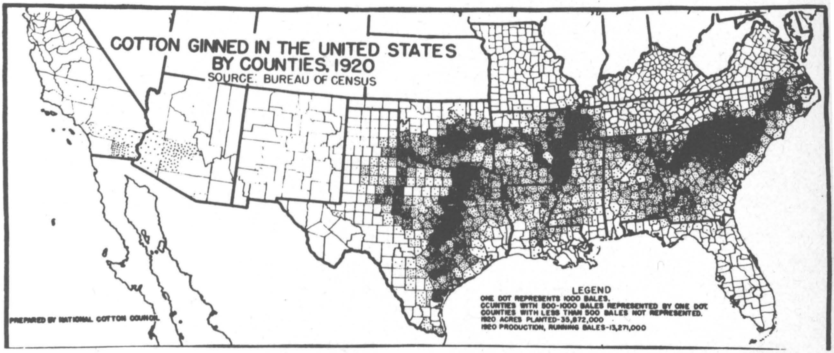
Cotton Production Trends

COMMERCIAL COTTON CULTURE in the United States is limited to areas having 200 or more frost-free days. Thus the Cotton Belt lies generally south of the 37^0 N parallel, except on the West Coast where it extends somewhat farther north. The location of major centers of production within the Cotton Belt, their potentials for production and the shifting pattern of cotton culture are a result, however, of a number of factors in addition to climate. A brief review of geographical shifts in cotton production in the past will show how trends set in motion many decades ago are strongly influencing the pattern today.

Cotton was introduced along the Atlantic Seaboard by the earliest settlers, and by the middle of the seventeenth century its culture formed an important part of the agriculture of this region. As the settlers moved westward, cotton became the main cash crop, first in the Piedmont, then in the Southeastern Coastal Plain and later in the South Central States.

By the time of the Civil War, the center of production had shifted from the worn-out soils of the Carolinas to the newer lands of the mid-South. Alabama and Mississippi then accounted for nearly one-half of all cotton grown in the country. The Civil War, with its destruction of the marketing, financing and transportation complex, was followed by development of the sharecropping system, and increasing numbers of small family-operated farms. The introduction of fertilizers and their increased use made possible the reclamation of many abandoned farms in the older areas. This also increased the yields in the newer sections. But the westward migration in search of new and cheap land continued. The period from 1880 to the advent of the boll weevil was marked by a very rapid expansion in cotton production throughout the Old Cotton Belt and in Louisiana, Arkansas, Oklahoma and Texas.

Figure 7.1 shows that the period 1920-58 was marked by a drastic decline in production in the rolling to hilly areas of the



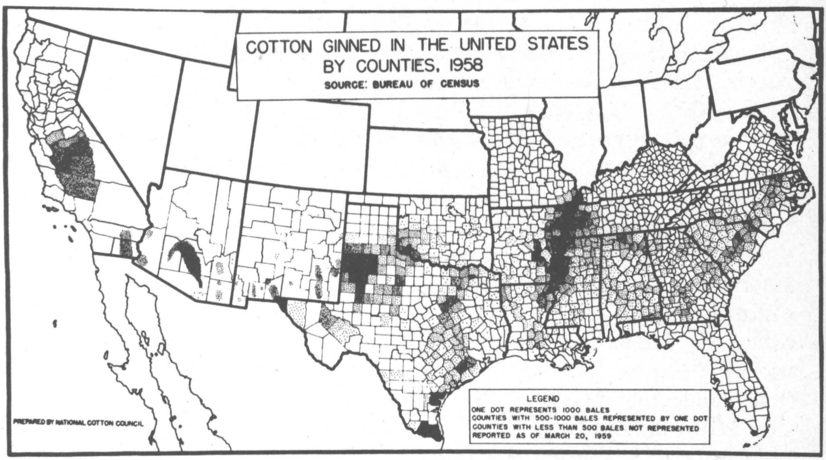


Fig. 7.1. Distribution of cotton production in the United States in 1920 and 1958. (Prepared by the National Cotton Council of America.)

Carolinas, Texas and Oklahoma, accompanied by a tremendous expansion in the Texas High Plains and the irrigated valleys of California, Arizona, New Mexico and Texas. These changes from 1940-60 are expressed in acres and percent shift for selected groups of states in Table 7.1. During this period, cotton acreage in the predominantly upland states of the Southeast has declined 69 percent. The Delta States have lost 57 percent of their acreage and Texas and Oklahoma 44 percent. The western states, in contrast, have gained 101 percent in cotton acreage. It should be noted, however, that the 1958 cotton acreage in the Southeast was the lowest in history, and that it increased in 1959 by about 60 percent. In contrast, acreage in the West changed little from

Table 7.1. Changes in Cotton Acreage in Different Sections of the Cotton Belt During the Period 1938-58 (4)

Section	Harvested cotton, 1,000 acres 1938	1948	1958	Percent increase or decrease during period
Ala., Ga., S.C.	5,310	4,039	1,263	-69
Miss., Ark., La.	5,777	5,815	2,504	-57
Texas, Okla.	10,440	9,638	5,805	-44
Calif., Ariz., N. Mex.	638	1,294	1,285	+101

1958 to 1959. Increased per-acre yields since 1920 have gone far toward maintaining total production on the declining acreage in the Old Cotton Belt. The Delta States produced the same amount in 1957 as in 1920, and on less than half the acreage, and the rest of the Southeast produced nearly one-half as much on one-sixth the acreage.

While this gives a gross picture of the movements of cotton culture within the entire Cotton Belt, it does not bring out important shifts within the various sections. In the Southeast, cotton acreage in the Delta Region of Mississippi, Arkansas, Louisiana and Tennessee has declined relatively little in comparison with the loss of the upland areas of those states. This is reflected to some extent by the difference in percentage reductions between Alabama, Georgia and South Carolina, and Mississippi, Arkansas and Louisiana. Similarly, while the total acreage of Texas and Oklahoma decreased 44 percent, there was a tremendous expansion in the High Plains, and the extreme upper and lower Rio Grande counties at the expense of the Black Prairie and Coastal Plain areas. It has been estimated, for example, that the High Plains alone will produce around two million bales in 1960, or one-half of Texas' total production.

Distribution of production in 1958, as given in Table 7.2, shows that the center of gravity of cotton production lies definitely in the Southwest. However, California and Arizona, with only 10 percent of the total cotton acreage, accounted for 20 percent of the production. The present core areas of production in the United States are located in the San Joaquin and Imperial Valleys of California, the Gila Valley of Arizona, the Pecos and Upper Rio Grande areas of New Mexico and Texas, the Texas High Plains, the lower Rio Grande and the Arkansas, Mississippi and Louisiana Delta.

Table 7.2. Distribution of Cotton Production in the United States by Regions, 1958 (4)

Region[a]	Harvested acreage	Production
	(Percent of U.S. total)	
Southeast	40	37
Southwest	50	43
West	10	20

[a] Southeast: States east of the Texas-Arkansas line; Southwest: Texas, Oklahoma and New Mexico; and West: California and Arizona.

FACTORS INFLUENCING LOCATION OF MAJOR COTTON PRODUCTION AREAS

A number of factors have played a part in the westward movement of cotton. Not the least of these have been the Federal production control programs begun during the thirties, and indirect subsidies such as cheap water provided by reclamation and irrigation programs in the West. The impact of these factors on cotton production is beyond the scope of this chapter and are merely recognized here as being potent influences.

The southwestern and western areas have some advantage in efficiency of production, however, to account in part for the shift. In general, these advantages derive from the facts that moisture is under the farmer's control, and that large-scale, mechanized production is the rule. Throughout the Southeast, excessively wet conditions at planting time frequently delay establishment and early growth of cotton, hinder weed control and encourage nitrogen loss by leaching and volatilization. When periods of deficient rainfall occur during the summer months, the low water-storage capacities of many of the soils make them unable to meet plant demands for moisture. During the harvest season, wet conditions often cause storm damage to the fibers and delay harvest.

Production in the arid region is totally dependent upon the availability of irrigation water and the land's suitability for irrigation. Large-scale operation, and the adequate credit and financing that goes with it, make specialized management and mechanization possible. In the humid region, the only cotton production center that has held its own in recent years is the Delta. This area is characterized by relatively level topography, larger operational units and more fertile soils than are found in the rest of the Southeast.

Several specific problems and characteristics that have had a bearing on the cotton industry should be mentioned.

Climate

A number of climatic factors are important to cotton production along with the length-of-growing-season requirement already mentioned. For example, spring mean temperatures must be high enough to insure rapid germination and early growth to avoid seedling diseases and resultant poor stands. An average spring temperature of about 60° F. is generally considered minimum. However, even where this condition is met, periods occur in some areas during which the temperature is too low for normal germination and growth. This condition would occur with greater frequency, for example, in the more northerly parts of the Belt and on the higher elevations, such as in the Texas High Plains. While this problem can be partially offset by later planting, delayed maturity and harvesting, and increased insect damage is the price paid. In the humid region, late planting aggravates the boll weevil problem and increases the hazard of crop damage by rain in the late fall. In general, the optimum planting date seems to be about two weeks after the average date of the last killing frost. Delay in planting beyond this point usually results in decreased yield. Frequently even a two-week delay in the humid region causes yield reductions of up to 20 percent. In most of the arid areas, planting can be done over a wider period without appreciable yield reduction. Sufficient time for the crop to mature before frost must be the chief consideration. Furthermore, since water is controlled, planting can be scheduled with certainty, whereas in the humid region it is dependent upon the weather. Sunshine is another factor of importance in cotton culture. Cotton is a sun-loving plant, and areas having as much as 50 percent cloudy weather have too little sunshine for the best growth of cotton. In the western part of the Belt the weather is typically bright and sunny with sunshine more than 90 percent of the time. The figure drops to a general level of 60 to 70 percent in the Southeast.

The total annual rainfall in the Old Cotton Belt of the Southeast ranges from 45 to 55 inches, which would appear at first glance to be adequate for high cotton yields. This is not the case, however. In the first place, considerably less than half the rainfall comes during the growing season. In addition, the high summer temperatures result in high rates of evaporation. These factors, combined with the low-profile moisture holding capacities, result in moisture becoming limiting for crop growth at times during practically every year. On the other hand, when excessive rainfall occurs in the spring, planting is delayed beyond optimum dates, and weed control becomes difficult. During the growing season, periods of wet weather complicate control of insects and favor attacks by disease organisms. Finally, at the end of the season, wet and windy weather, often the backlash of fall hurricanes, delays harvesting and lowers the quality of the crop. So, while the humid areas have an advantage in their near-adequate rainfall, it is at least partially offset by the distinct hazards of excessive and ill-timed moisture.

As a result of its relatively high annual rainfall, the Southeast is a region of many streams and rivers. Subterranean water resources are excellent in some areas. In this respect the Old Cotton Belt as a whole is in a favorable position. Supplemental irrigation of cotton and other crops has expanded rapidly since 1950, especially in the Delta where abundant water lies near the surface and only minor land forming is generally required for furrow irrigation. One important obstacle to full development of the water resources of the South is the lack of up-to-date regulatory legislation. This problem has been widely recognized, especially with the rapidly growing industrial demands for water, and most, if not all of the states, are in the process of correcting it.

In the arid region, in contrast, crop production is totally dependent upon the availability and quality of water for irrigation. Expansion of crop production in these areas is strictly limited, both by the total water supply and by increasing competition for industrial and urban use. For example, it has been shown (9) that in 1958, water was pumped from the ground over a 25,000-square-mile area of the high plains of Texas and New Mexico at a rate 140 times that at which it was being replenished. Further, increasing salt content of underground water often becomes a complicating factor when the supply is overburdened. So, while the possibility of moisture control through irrigation is a distinct advantage in growing cotton, the limited water resources of arid areas impose restrictions on the potential production of these regions.

Soils

Cotton is grown successfully on soils that vary widely in chemical and physical properties from the acid, highly leached soils of the Southeast to the neutral-to-alkaline, medium-textured soils of the arid regions. In fact, it is grown on more than half of the identified, great soil groups in the United States. The bulk of production, however, is on six of these: the Red-Yellow Podsolic soils, the Grumosolic soils, the Alluvial soils, the Reddish Prairie soils and the Reddish-Brown Lateritic soils (2). Within each group, of course, are soils poorly adapted to cotton culture, usually because of unsuitable topography, shallowness, poor internal drainage, extremes of texture or alkalinity and salinity. While native soil fertility was an important influence in the shifting of production to newer soils in earlier times, advances in knowledge of the nutrient requirements of the crop and the development of fertilizer technology have now largely offset this factor.

In general, the soils of the Southeast require lime and complete fertilization for maximum cotton yields, whereas only nitrogen and phosphorus are needed in most of the Southwest and West. Here again, however, the Delta has an advantage over most of the Southeast and is on an equal footing with the West. These Alluvial soils produce high yields with only nitrogen fertilization, although the need for mineral fertilization will undoubtedly increase with time.

Water-holding capacity is an important characteristic that affects production, especially in the humid region. The Red-Yellow Podsolic soils of the Southeast generally have a low capacity, often in the order of only one inch per foot of profile. Moisture stress develops sooner on these soils than, for example, on the Alluvial soils of the Delta during periods of drouth that occur frequently during the summer.

Good internal drainage is a prerequisite for successful cotton culture. Poorly or imperfectly drained soils frequently cannot be planted at the proper time, and weed control is difficult. Poor drainage is the chief reason why the Grumosolic soils of Alabama and Mississippi Black Prairie, which formed an important cotton production center before the advent of the boll weevil, are now primarily devoted to livestock. In Texas, the same soils, but under lower rainfall, are used successfully for cotton. In the Delta, the bulk of the cotton is grown on the medium-textured, better-drained soils, while the finer, more poorly drained members are used for pasture, soybeans and other crops. Similarly, the soils used for cotton culture in the arid and semi-arid regions are generally the intermediate textured and permeable type with good internal drainage.

Topography

The 1958 distribution of cotton production as shown in Figure 7.1, illustrates how the areas of relatively level land gained while in the hill sections production was decreasing. Lack of adaptability to mechanization, and susceptibility to erosion under intensive cotton culture, have placed these traditional producing areas of the Old Cotton Belt at a serious competitive disadvantage with respect to the more nearly level river flood plains of the South and West and the Texas High Plains. It should be mentioned, however, that the extensive areas of gently rolling land in the Lower Coastal Plain of the Carolinas and Georgia are well suited to both mechanization and supplemental irrigation. Drainage is the first requirement for using most of this area.

Insects and Diseases

The boll weevil has been the most important single cause of geographical shifts of cotton production since 1920. As the boll weevil advanced from the Mexican border to the Atlantic seaboard — from 1900 to about 1920 — cotton production dropped in state after state to only a fraction of previous levels, particularly in the southern parts of the Belt. This threatened collapse of the entire economy of the region stimulated movement to areas less affected. It intensified the search for remedial measures that resulted in insecticides development, varietal improvements and increased use of fertilizers and other improved practices. All these tended to offset losses caused by the weevil. The advances began an upward swing in production efficiency that has been maintained. Even so, boll weevils still take a large annual toll of the crop throughout the Old Cotton Belt. In 1950, for example, the estimated loss was 23 percent. These losses, when added to the cost of control measures (which runs up to $30.00 per acre), places the affected areas at a competitive disadvantage with areas where the weevil is not a problem.

The arid region, while free of the boll weevil, does have insect problems, including some insects not common to the humid areas, such as pink boll worms, Lygus bugs and salt marsh caterpillars. Control of these and other insects requires on the average about four applications of insecticides per season at a cost that commonly runs up to $10.00 per acre. Thus, the actual cost of insect control here is considerably less. Furthermore, the effectiveness of control measures is usually considerably greater as a result of climate, which is one of the important reasons for the higher cotton yields in the West.

Diseases have been a serious problem throughout the Cotton Belt and there seems to be little over-all difference in losses among the various sections, as indicated by the 1959 estimates

Table 7.3. Estimated Reduction in Cotton Yield as a Result of Disease Damage, 1959[a]

State	Average estimated yield reduction
	(Percent)
Calif., Ariz., N. Mex.	10.80
Texas, Okla.	13.63
Ark., La., Miss.	10.75
Ala., Ga., Tenn., N.C., S.C.	12.96

[a] Estimates of the Cotton Disease Council.

recorded in Table 7.3. While losses are still serious, they have been reduced markedly through aggressive breeding programs and rapid adoption of improved, resistant varieties as they are developed.

Economic Factors

The general pattern of small, family-operated farms in the Old Cotton Belt was formed after the breakup of the large holdings following the Civil War. The average size of farms in the more recently developed areas of the West and Southwest are larger, of necessity, because of the much larger capital investment required for intensive production under irrigation. This difference is clearly illustrated by the figures of Table 7.4, although data were not yet compiled for the West. Average cotton acreage of farms in the Southeastern Coastal Plain and Piedmont are only 6.1 and 11.6 acres, respectively, with capital investments

Table 7.4. Average Size, Cotton Acreage and Capital Investments of Typical Cotton Farms (5)

	Total acreage	Cotton acreage	Capital investment
Southern Coastal Plain	163	6.1	$ 13,540
Piedmont	183	11.6	18,400
Texas Black Prairie	185	36.3	31,340
Texas High Plains			
Non-irrigated	404	110	53,390
Irrigated	351	146	103,590
Delta			
Small farmers	58	11	13,110
Large farmers	1,000	197	203,350

Table 7.5. Allotted Cotton Acreage and Average Allotment Per Farm in Different Sections of the Cotton Belt, 1960 (6)

Section	Total acreage[a]	Average allotment
		(Acres)
Ala., Ga., S.C.	2,568,761	9.1
Miss., La., Ark.	3,679,047	17.1
Texas, Okla.	8,127,515	32.8
Calif., Ariz., N. Mex.	1,566,940	61.2

[a] Represents 97 percent of the total U.S. cotton acreage.

of only about 14 and 18 thousand dollars. In the irrigated Texas High Plains, by contrast, average cotton acreage per farm is 146 acres, and the capital investment over 100 thousand dollars. While the Delta, which is holding its own easily in cotton, does have a number of small farms, it is typically an area of much larger operating units than the rest of the South.

The average 1960 cotton allotments per farm in different parts of the Cotton Belt are listed in Table 7.5. In the upland areas of the Southeast, the oldest cotton-producing section of the country, it is only 9.1 acres per farm. It is nearly double that in the Delta States. While data are not at hand for the hill counties of these states, their operating units are much smaller than in the Delta counties. The average allotment in Texas and Oklahoma is 32.8 acres, and that of the western states 61.2.

Table 7.6 gives an idea of the size distribution of operating units in representative groups of states in different sections of the Cotton Belt. In the upland areas of the Southeast, 86 percent of the farms had cotton allotments of less than 15 acres, a unit

Table 7.6. Size Distribution of Choice "A" Cotton Allotments in Different Sections of the Cotton Belt, 1959[a] (7)

Section	Percentage of total allotments			
	Less than 15 acres	15 to 50 acres	50 to 100 acres	More than 100 acres
Ala., Ga., S.C.	86.0	11.9	1.5	0.6
Miss., La., Ark.	78.5	15.8	3.2	2.7
Texas, Okla.	54.7	32.0	9.1	4.2
Calif., Ariz., N. Mex.	44.2	31.7	12.5	11.6

[a] Choice "A" allotments represented about 92 percent of the total.

too small to justify conversion from mule to tractor power, considering the cotton alone. It should be mentioned, however, that a large number of these small allotments have not been planted in the past. Under regulations in effect until 1960, allotments turned in were lost, often to the western area. Consequently, small allotments simply have either been held for subsidy payments or rented to larger operators in the vicinity. Under 1960 rules, 75 percent of an allotment must be planted or it must be turned in. But, now, if the allotment is turned in, it is retained in the state, and the individual does not lose the right of reassignment at a later date. This change will go far in stabilizing the production pattern within regions, and will make for more efficient production on larger units. The percentage of small allotments decreases rapidly from East to West with an increasing proportion of farms with allotments of more than 50 acres, where extending mechanization to harvesting becomes an economic possibility. One-fourth of all farms growing cotton in California, Arizona and New Mexico have allotments of more than 50 acres, and half of these are above 100 acres.

The possible gross income from cotton on the bulk of the farms of the Southeast under the present control program is inadequate to support the degree of mechanization required for efficient production. As a result, small operators are forced to seek alternative means of maintaining income. More and more, industry is helping bridge the gap. Those who elect to continue farming are finding the pressure to shift to other farming enterprises increasingly difficult to resist. And here, tradition is an extremely important factor working toward retention of cotton as long as possible. Cotton culture has been practiced for generations, and both the farmer and farm labor are thoroughly familiar with the management of the crop under their particular conditions. Furthermore, markets are established, and private financing is geared to this crop in much of the region. Changing over to a new system requires development of new skills, and, usually, increased capital investment. Many small farmers find these most difficult. Basically, however, the problem is one of finding an alternative cash crop with a ready market and an adequate income potential, but a crop not already under acreage restriction. In spite of these problems, however, change is taking place, as indicated by the figures of Table 7.7. During the two decades 1930 to 1950, the acreages of such crops as soybeans, oats and peanuts have increased markedly in the Southeast. Also, the cattle industry is definitely moving, this time from West to East. Since 1938 the number of cattle in the Southeast has nearly doubled, and quality has improved markedly. And the trend is still upward.

Table 7.7. Changes in Proportion of Land Used for Production of Crops Other Than Cotton in the Seven Principal Cotton Producing States of the Southeast, 1930-50 (8)

Item	Percent change
Oats	+348
Soybeans	+1,402
Peanuts	+84
Hay	+115
Pasture	+54
Tobacco	-18

While cattle production does not solve the small farm operator's problem it does give the larger farm operator an alternative source of income and provides a means of keeping labor busy during the off season for cotton.

These statements should not in any sense be taken to indicate that a complete shift of cotton production from the non-Delta states of the Southeast is inevitable. To the contrary, in many local areas and on many operating units throughout the region, a combination of factors favor successful competition. Under present conditions, however, it appears that production will be concentrated in such areas and on such units to a much greater extent than exists even now.

YIELD POTENTIAL IN DIFFERENT SECTIONS OF THE COTTON BELT

Yield potentials of farming areas cannot be accurately determined but reasonable estimates can be based on the results of field experiments, crop-yield contests and surveys of farmers' yields where intensive production practices are applied. The estimates given here also include the ideas of a number of research and extension workers who were kind enough to give their views.

Considering the irrigated areas of the Southwest and West, yields of short staple cotton of up to 4 bales per acre are possible under the best conditions on individual farms and in field experiments. This is true in practically all of the major producing areas from the Lower Rio Grande to the San Joaquin Valley. Yields of 2 to 3 bales are not uncommon on farms with good management. This is not especially surprising in light of the high average yields in these areas.

What is surprising is that yields of the same order of magnitude can be made in other parts of the Belt, with supplemental irrigation, increased fertilization and intensive insect control. A good example of this is shown in Figure 7.2. This experiment was carried out cooperatively by the ARS and the Alabama Experiment Station, on a typical Coastal Plain soil at Thorsby, Alabama, during 1957-59, inclusive. Although only the data for the first two years are presented, the results have been consistent for the entire period. Top yields have been around 5,000 pounds of seed cotton averaging about 38 percent lint, making just under 4 bales per acre. The experiment included as base treatments mechanical disruption of a plow pan that had formed in the soil prior to the experiment, fumigation for control of nematodes, heavy applications of mineral fertilizer and dusting and spraying, as required, to control insects. In addition to the high yield potential demonstrated, this experiment emphasized several points not previously recognized. Cotton has been generally regarded in the South as a drouth-resistant crop, yet highest yields were made in this experiment with the highest soil moisture level used. Also, nitrogen applications of more than about 120 pounds per acre were generally considered adequate for maximum yields possible in the Southeast, yet there was a strong response up to 240 pounds with the highest moisture level.

These high yields, while indicative of potential, were only

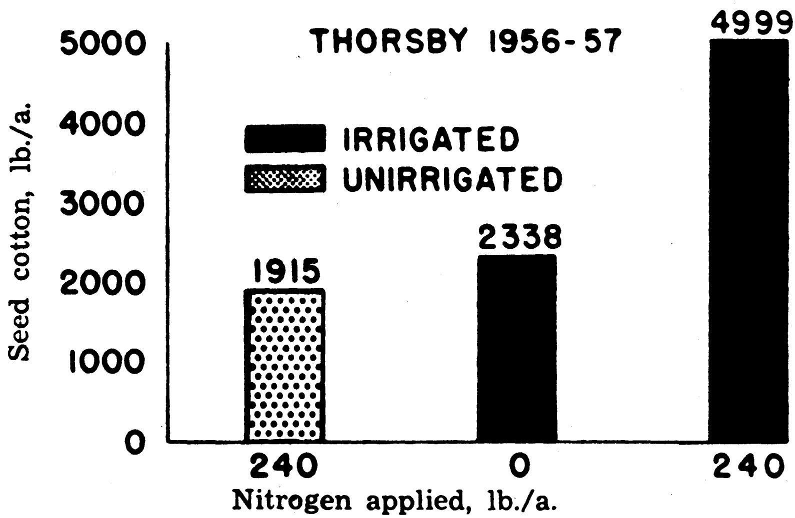


Fig. 7.2. Yields of cotton with high rates of nitrogen and moisture alone and in combination, 1956-57. (3)

obtained at the price of rank vegetative growth and delayed harvest. Also, there was considerable lodging, due primarily to the tremendous weight of fruit set, which aggravated boll rot and harvesting problems. The effect on maturity is illustrated in Figure 7.3, which shows that the gain for both irrigation and increased rates of nitrogen is in fruit that matures during the later part of the growing season. As has been mentioned earlier, the weather hazard increases as the harvest date is advanced into the

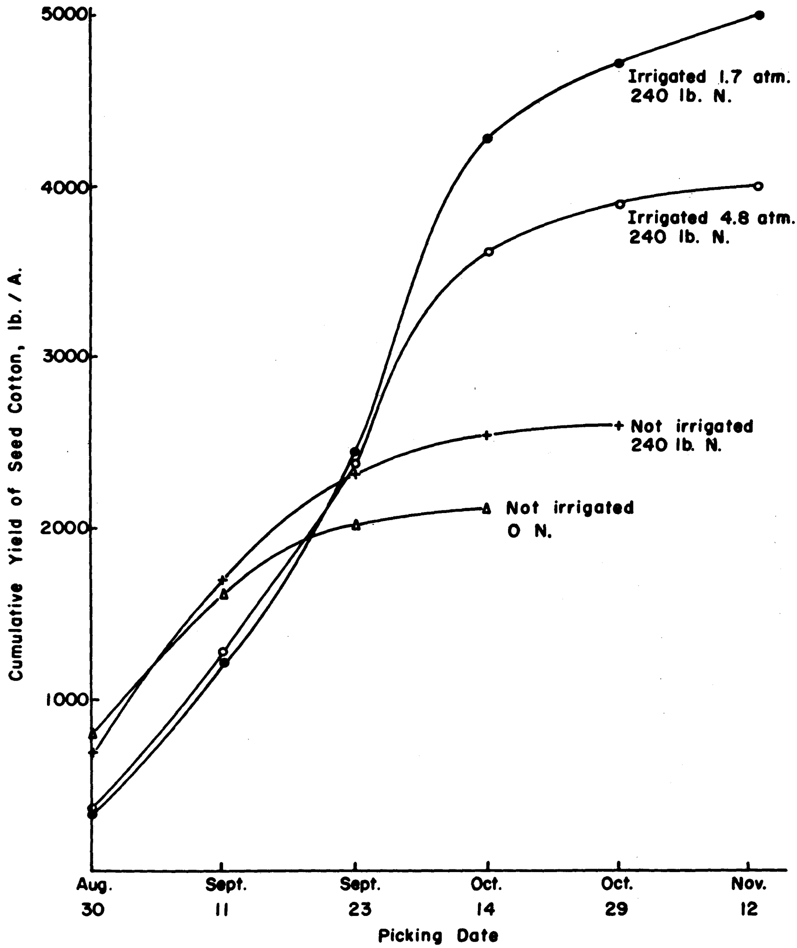


Fig. 7.3. Effect of moisture level at a high rate of nitrogen on yield of cotton. Thorsby, Ala. 1957.

Table 7.8. Top Yields Made in the Mississippi Total Farm Yield Cotton Production Program,[a] 1959 (10)

County	Name	Measured acres	Lbs. lint yield per acre
	0-4.9 Acres size cotton allotment		
Lincoln	Eldon Smith	3.9	1,076.0
	5-14.9 Acres size cotton allotment		
Carroll	J. M. Stanford	12.6	1,183.0
	15-99.9 Acres size cotton allotment		
Sharkey	Maxie Barnett	16.9	1,084.0
	100-499.9 Acres size cotton allotment		
Holmes	H. L. Nichols, Jr.	376.0	1,276.0
	500 Acres up size cotton allotment		
Washington	Marion Stevens	586.0	990.0
Five state highest average lint yield per acre			1,121.8

[a] Each farmer produced the state's highest lint yield per acre within the size cotton acreage allotment.

fall. These data, then, cannot be interpreted as representing present practical possibilities for commercial production in the Southeast. Solution of the several problems raised could, however, give them practical application.

Turning to observations made on farmers' fields, the results given in Table 7.8 should indicate present yield potentials under farmer management in a typical southeastern state. These highest average yields came from both Delta and upland counties. The five highest state yields averaged about 2 1/4 bales per acre, which is very little below the top yields reported on well-managed farms in the West. Turning to a much broader sampling of the same state, Table 7.9 shows average yields of 253 farms entered in the Mississippi Total Farm Yield Cotton Production Program in 1959. Yields on 37 farms in the Lower Delta section approached 2 bales per acre, while those in the southeastern part of the state dropped to a little over 1 bale. The average for the 253 farms was 1 1/2 bales.

These, and similar observations that have been made in other southeastern states, lead to the conclusion that 1 1/2 bales per acre are immediately within the reach of cotton farmers of the region without irrigation, but simply by application of recommended practices. With irrigation, present practical yield potential would probably be about 2 1/2 bales.

Table 7.9. Average Yields of Lint by Sections of the State in the Mississippi Total Farm Yield Cotton Production Program, 1959 (10)

Location in state	No. of farms in contest	Average yield of program growers
		(Lbs. lint per acre)
Upper delta	18	854
North central	22	873
Northeast	50	749
Lower delta	37	904
Central	38	864
East central	33	663
Southwest	10	758
South central	29	610
Southeast	16	690
Weighted average for 253 farms		777
State average		516

The dry-land cotton producing areas of Texas and Oklahoma have a lower yield potential and average yield than the rest of the Belt. The general average yield is somewhat less than 1/2 bale per acre. In exceptionally good years, yields approach a bale, but the estimated maximum obtainable, on the average, by use of all known improved practices would be around 3/4 bale per acre. Thus, present yields in this region are close to the estimated potential. The chief limitations are soil moisture and structure.

PRESENT LEVELS OF APPLICATION OF TECHNOLOGY IN COTTON PRODUCTION

As was noted earlier, cotton yields and efficiency of production began an upward swing as a result of research begun in about 1920, and the trend has been even more marked since about 1950. Average yields increased from 30 to 40 percent during the decade 1947-58 over the previous 10 years (Table 7.10). Also, Figure 7.4 shows how production per man-hour has increased even more rapidly than per-acre yields. Technological advances in a number of fields have combined to make this possible. Further, it is impossible to evaluate fully the impact of improvement in one area of technology alone, since each interacts with the others in determining the potential effect on crop yield. This was illustrated clearly by the interaction of nitrogen fertilization and level of irrigation in the experiment at Thorsby, Alabama.

Table 7.10. Average Yield of Lint Cotton and Yield Trends by Regions, 1938-57 (4)

Region	Average lint yield 1938-47	1948-57	Increase
	(Lb./A)	(Lb./A)	(Percent)
Southeastern	290	379	34
Southwestern	182	238	31
Western	560	785	40

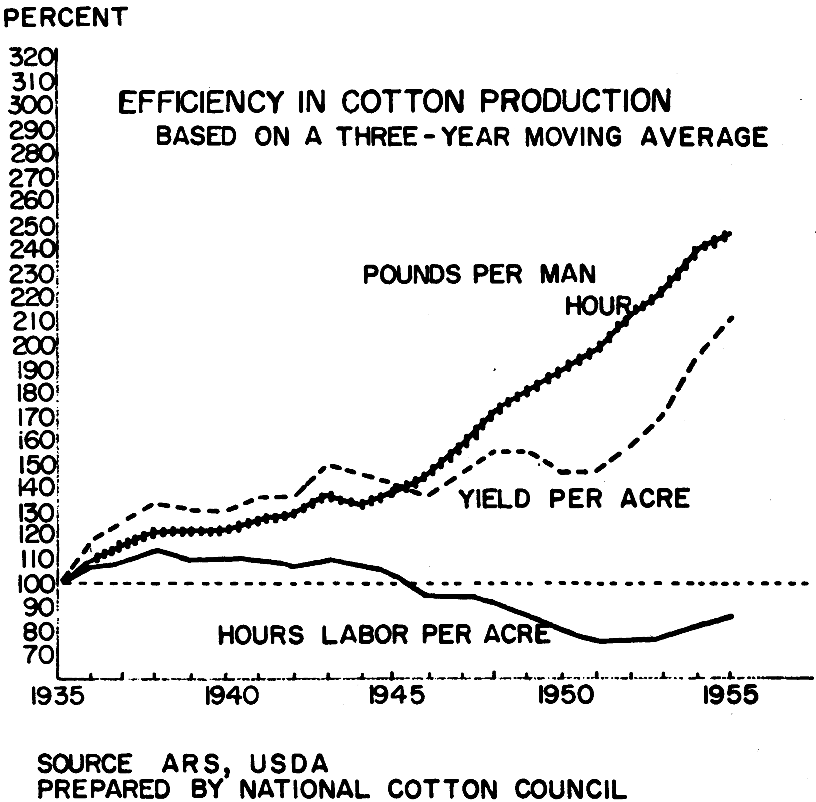


Fig. 7.4. Changes in cotton production efficiency in the United States, 1935-55.

Improved Varieties

The aggressive breeding programs of federal, state and private agencies have developed improved varieties adapted to the various cotton producing areas, and these are used in all commercial cotton plantings. In the West, particularly, variety standardization on a state basis has gone far toward yield and quality improvement. This is recognized in the market, and buying patterns have developed on the basis of the particular lint qualities of each variety. Standardization of varieties has not progressed as far in other parts of the country. In many parts of the Belt, soil and climatic conditions are too variable within a state to make the one-variety-state approach feasible, but locally adapted, improved varieties are usually planted. In general, it appears that near-maximum use is being made of the best available varieties throughout the Belt. Their full potential is not being realized though, because of limitations imposed by other management practices.

Fertilization

The latest data on fertilizer use on cotton, quoted in Table 7.11, show that all areas are using nitrogen and phosphorus, but that potash is used chiefly in the humid areas. Potash generally is not needed in the semi-arid and arid regions, and phosphorus is often used more as insurance than as a result of demonstrated requirement. Nitrogen is the primary limiting element, and recent inquiries of research and extension workers familiar with the fertilization practices of their area indicate that average nitrogen rates are now considerably higher in some areas than the levels shown in Table 7.11. For example, nitrogen rates are estimated at about 100 pounds per acre in the irrigated areas of the West and Southwest and in the Delta. Rates currently being used in the upland areas of the Southeast and in the dryland cotton sections of the Southwest have probably changed little.

In general, present average nitrogen use in the areas of intensive production, such as the Delta and irrigated regions, is probably not more than 20 percent below the maximum for economic return at present level of other practices. Of course, expansion of supplemental irrigation and more effective insect control would widen the gap appreciably. In the upland areas of the Southeast, however, present nitrogen use is only about one-half the recommended level and marked improvement in yields could be made here. Furthermore, fertilization with phosphorus and

Table 7.11. Average Fertilizer Use on Cotton by Major Producing States, 1954 (1)

State	Rate of application per fertilized acre		
	Lbs. N	Lbs. P_2O_5	Lbs. K_2O
Alabama	37	48	31
Arkansas	39	21	34
California	81	16	1
Georgia	40	45	48
Louisiana	53	18	13
Mississippi	70	20	16
Missouri	40	31	35
New Mexico	43	32	--
North Carolina	33	47	45
Oklahoma	10	19	7
South Carolina	36	45	31
Tennessee	41	35	40
Texas	46	31	7

potassium is essential for satisfactory cotton yields throughout this area, and present average usage is considerably below recommended rates, probably by as much as 50 percent.

In general, then, it appears that there is little opportunity for improved yields from increased rates of fertilization except in the southeastern uplands, without a simultaneous intensification of other production practices, especially insect control.

Insect Control

Some measure of insect control is absolutely essential to economic cotton production throughout the Belt. The problem is, of course, much greater in the humid region than in the West, where control has about reached an economically optimum level, except that some improvement could be made in the timing of applications.

Since absolute control of insects is not possible with present materials and methods, the desirable degree of control becomes a matter of economics. As dusting and spraying frequency is increased, a point is reached beyond which the cost is not compensated by the expected yield increase. In the humid region, and especially in upland areas of small fields where dusting by plane is not feasible, control is considerably below the desired level. In the Delta, control is better because the larger operating units are better equipped and financed for taking advantage of the latest improvements in procedures and insecticides. Even so, it has been estimated that average yields in the Delta could be increased by 100 pounds of lint by strict adherence to recommended insect control measures. In the upland areas the improvement would be perhaps twice as great.

Mechanization

Rising costs of farm labor and the diminishing supply have resulted in the rapid introduction of machines for practically every operation in cotton culture. Machine harvest is the greatest single labor-saving operation. One spindle picker can harvest as much cotton per day as 50 to 70 hand pickers. It does this with an efficiency above 90 percent and very little reduction in grade through the use of defoliants and modern ginning equipment.

Weed control is a very important and difficult problem. Combinations of pre- and post-emergence herbicides, cross plowing and flame cultivation can practically eliminate hand hoeing and get the job done on time. Chemical weed control alone can reduce the hand-hoe labor requirements by up to 90 percent. In the Southeast, particularly, use of herbicides is expanding at a tremendous rate, and is a factor that will hasten complete mechanization in the region. A farm labor force cannot be maintained for picking alone, and itinerant or local seasonal labor cannot be depended upon.

Power stalk shredders and multi-row equipment for land preparation, planting and fertilizing mean planting more acres on time with less labor. Improved ground equipment such as high-pressure mist blowers, and the widespread use of airplanes for insecticide application, permit far better insect control.

To take advantage of these technological advances, however, requires a high gross return and a high capital investment, conditions that can be met only on the larger farms. For example, conversion to tractor power is not economically possible for less than about 15 acres, and purchase of a picker requires around 100 acres. As a result, the Delta Region and the irrigated areas of the Southwest and West are highly mechanized, while the upland areas of the South and Southeast have made much slower progress in this direction. However, smaller, less expensive spindle-type pickers have just appeared on the market. These appear to have real possibilities for farms with cotton allotments in the 50 to 100 acre range. At present, it is estimated that around 60 percent of the cotton produced in the Delta and the irrigated areas is harvested mechanically, but no more than 10 percent of that grown in the rest of the Southeast is mechanically picked. Of course, tractor power has almost completely replaced the mule throughout the Belt, accounting for at least 95 percent of the total production.

Moisture Control

There is room for considerable improvement in moisture control throughout the Cotton Belt. In the irrigated regions, research and extension workers feel improvements can be made in efficiency of water application and in timing of irrigations. In the humid region, practices that decrease runoff and evaporation losses and that encourage deeper plant rooting could add appreciably to the moisture available for crop growth during periods between rains.

In addition, the use of supplemental irrigation offers one of the most promising ways of making real advances in cotton production in those areas where it is practicable. This has been realized and was reflected in the increases in irrigated acreage during the 1950's. A weighted average, calculated from the figures quoted in Table 7.12, shows that about 14 percent of the cotton acreage in Arkansas, Louisiana and Mississippi was irrigated in 1956. Most of this acreage was in the Delta. The figures for Alabama indicate that less than 5 percent is probably irrigated in the rest of the Southeast. Further exploitation of supplemental irrigation, is, like mechanization, dependent upon farm resources and suitability of the land. Continuing expansion can be expected throughout the Delta and on favorably situated individual farms of the uplands, but widespread use of supplemental irrigation in the Southeast does not appear likely.

Table 7.12. Use of Irrigation in the Production of Cotton in Four Southeastern States, 1956

State	Irrigated cotton	
	(Acres)	(Percent)
Alabama	35,300	3.5
Arkansas	230,438	17.0
Louisiana	52,135	9.2
Mississippi	195,721	12.3

Source: Statistics compiled by the National Cotton Council of America.

SUMMARY

Aside from governmental production control programs, the locations of core areas of cotton production in the United States are primarily a result of climatic, topographic and economic factors. These factors have resulted in a marked decline in production on the small farms of the Southeast and those of the dryland areas of the Southwest. This decline has been accompanied by a concentration of production in the Delta and the irrigated areas of Texas and the West, where practically attainable yields with present technology are higher, operating units are larger and production efficiency greater.

Present levels of application of improved practices are higher in these centers of production than are economically possible in much of the remainder of the Cotton Belt. However, marked improvement in yield and production efficiency could be made, especially in the Southeast, through intensified use of present, locally recommended practices.

Potential yields attainable through maximum use of intensive production practices do not appear to be appreciably different among the various cotton producing areas. The practical application of these practices poses problems in the Southeast, however, that are not encountered in the arid region.

Further expansion of cotton production in the arid region will be restricted by the limited amount of water available for irrigation and will be at the expense of other crops. Further shifts will undoubtedly occur within the various areas, however, from the smaller, less efficient units to larger, more favorably situated farms.

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