Some effects of government programs on Arizona upland cotton allotments

SOME EFFECTS OF GOVERNMENT PROGRAMS ON ARIZONA UPLAND COTTON ALLOTMENTS

by

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ABSTRACT

Analysis of the effects of recent upland cotton programs on the organization, income, and allotment value for representative Arizona cotton farms was the focus for this research study. Stepwise multiple-linear-regression analysis was applied to historical farm sales data using sale price as a dependent variable. Allotment value estimates were derived from the regression analysis and graphically compared to per-acre allotment income estimates for representative Arizona farms.

This study also analyzed the 1970 allotment yield and ownership patterns in Arizona's five major cotton-producing counties. Multiple regression analysis was used to investigate the relationship between projected yield and ownership characteristics for Arizona cotton farms. The farms were then classified according to their 1970 payment level, and analysis of variance techniques were used to compare group means for ownership variables and projected yield.

Per-acre allotment income and value in Arizona have trended downward since 1963. This decline can probably be attributed to the increasing uncertainty regarding future benefits to be derived from the government programs.

Allotment ownership characteristics exhibited neither a consistent nor a significant relationship to yield variability. In each of the counties, and for the state as a whole, significant differences in average projected yield existed between farm-size groups.

CHAPTER I

INTRODUCTION

The Federal government has long sought to influence prices for basic agricultural commodities for the purpose of maintaining price and income levels for producers of such commodities. The basic approach has been price-support programs in conjunction with production control measures.

Commodities produced under the auspices of federal programs generally enjoy favorable price levels and stable income expectations. Previous studies have shown that the production-limiting devices take on values based on the capitalization of the income flow directly attributable to the control device. Such production control devices are usually in the form of acreage allotments.

The low risk factor and stable income expectations for these regulated commodities provide ample incentive for individual producers to increase their production within the limits of the acreage controls by substituting inputs other than land into the production process. The ultimate consequence of this behavior is excess aggregate supplies, despite production limitations. In order to maintain price levels, these surpluses must be removed from the market. Removal of such surpluses is costly to the government.

Of the current government agricultural programs, the program for upland cotton has probably been the most costly and controversial. Faced with chronic cotton surpluses, it has been necessary for the government to reduce allotment acreage over the years to avoid accumulating unmanageable surplus stocks of cotton.

The impact of these acreage reductions on allotment values, aggregate production levels, and farm income are of concern to policy-makers and cotton growers. In a state such as Arizona, which relies upon cotton for a substantial portion of its farm income, any alteration of the profitability of cotton would be expected to have a substantial impact on the state's agricultural economy.

This study is concerned with analyzing some of the effects of government programs on income flows to Arizona cotton growers and the value of Arizona upland cotton allotments.

Organization and Objectives

The remainder of this thesis is organized in the following manner. A narrative of the interplay of the markets for cotton and government programs in the period since World War II is presented in Chapter II. Chapter III discusses the relationship between income and cotton programs, and how these factors affect upland cotton allotment value. Chapter IV presents an analysis of per-acre upland cotton allotment value trends in central Arizona for the period 1961-1967. An analysis of the ownership characteristics and productivity of the cotton allotments in the five major cotton-producing counties of Arizona is the subject of Chapter V. In the final chapter, results of the total analysis are discussed and final conclusions are presented.

The objectives of this thesis are:

1. To conceptualize the relationship between government programs and the income flows to cotton and value of upland cotton allotment acreage.
2. To develop estimates for per-acre upland cotton allotment values in central Arizona and compare them with estimates of per-acre net incomes for cotton.
3. To analyze the structure of ownership and leasing of upland cotton allotments for various size farm operations in order to appraise the potential effects of programs that limit government payments to individual farmers.

CHAPTER II

THE POST-WORLD WAR II COTTON SITUATION: A BRIEF HISTORY OF PRICE MANAGEMENT IN THE MARKET[1]

The traditional objective of government programs for cotton has been the stabilization and maintenance of the level of cotton prices. Under certain circumstances, the stabilization of per-unit prices acts to stabilize individual farm incomes. The government pursues these objectives in the fashion described in the following section.

Basic Theory of Price Regulation

Price is ultimately a function of market supply and demand conditions. It is beyond the scope of this discussion to investigate all of the factors which influence supply levels and demand levels, or to attempt to precisely define the nature of the cotton market. Rather, government influence on the workings of the market mechanism are of interest here.

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1. For a more detailed discussion of the history of U. S. Upland Cotton Programs, see the following sources which provided the historical information for this chapter: United States Department of Agriculture, Economic Research Service, Cotton Situation, Washington, D.C., a bimonthly publication. Cotton and Other Fiber Problems and Policies in the United States, National Advisory Commission on Food and Fiber, Washington, D.C., 1967, especially "The Cotton Surplus Problem," by Rodney Whitaker, pp. 81-166.

The demand curve for cotton is typically price-inelastic. As such, small percentage changes in the cotton supply bring about relatively large percentage changes in cotton prices. Assuming that the level of demand is known beforehand, theoretically supply levels can be adjusted so as to achieve a balance with demand at the desired price levels. In the case of cotton, the adjustment is ultimately achieved with acreage allotments. Any fluctuations in supply from the desired level can be dampened by government purchasing or by the disposal of cotton surpluses.

Figure 1 depicts the relationships in this model. The demand line (DD) is initially assumed to be constant and price-inelastic. The desired price-support level is P_D, and Q_D represents the quantity that the market will demand at price P_D. Line SS represents a supply level that will achieve price level P_D without government purchase of cotton.

In this model, the supply curve represents the output response to variation in price, while acres planted and the state of the arts are held constant. This supply curve will tend to drift to the right as higher yielding varieties and improved production practices are brought into use over a period of years.

An increase in supply level as shown by line S'S' brings about a proportionately larger reduction in price (P_D to P') than in quantity (Q_D to Q'). The government

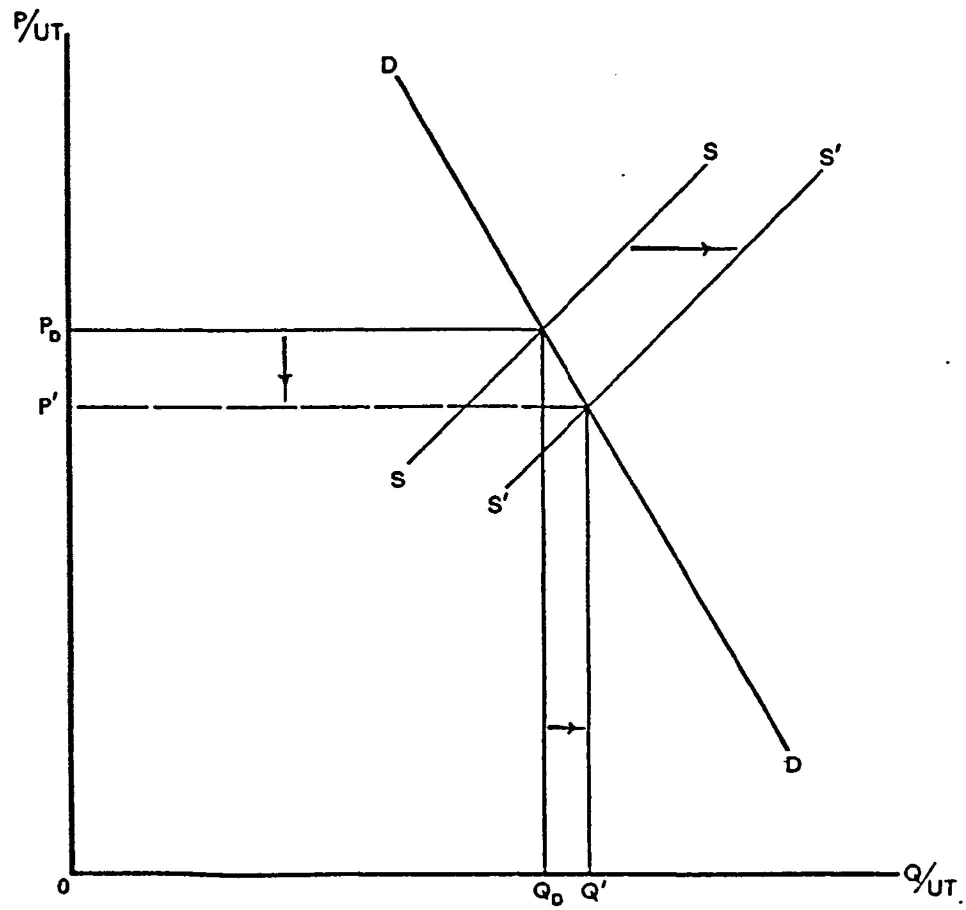


Figure 1. Basic Market Structure for Upland Cotton

can maintain P_D by standing ready to purchase cotton at price P_D, and thus remove quantity Q_DQ' from the market. This quantity Q_DQ' can be held in stocks and be made available for purchase at price P_D when supply levels fail to reach Q_D, thus keeping the price level of cotton very near P_D.

Effects of Surplus Production Trends

Implicit in this theoretical construct is the assumption that, in a long-run context, quantities supplied will equal quantities demanded at the desired price level. In other words, price and supply levels should be adjusted so as to maintain a long-run supply and demand equilibrium. Should a long-term period of excess production occur, the government would accumulate large stocks of cotton. The stabilization of prices at levels favorable to the producer encourages individual producers to accelerate the forces leading to increased per-acre yields, which compounds the problem of aggregate surplus production levels.

The government may relieve this problem of chronic surplus production by periodically reducing total production, either by reducing the total allotment size or by lowering the price-support level. The former measure effectively shifts the supply curve to the left; the lower support price has the effect of increasing the quantity demanded while reducing the quantity supplied and reducing farm income.

Two-Sector Market Model

The market for U. S. cotton is best described with a model showing two separate markets, as illustrated in Figure 2. In this model, the U. S. market situation and the Free Foreign World (FFW) market situation are shown as two separate markets, each with its own supply and demand curves. Each sector has the same scales on the price and quantity axes. These two markets can reach an equilibrium with trade. Assuming that no costs or institutional barriers are associated with trade, the equilibrium price will be the same in both markets. The market with the lower "no-trade" equilibrium price (U. S.) will export to the market with the higher "no-trade" equilibrium price (FFW) until the price equilizes and the quantity exported is equal to the quantity imported (Q_1Q_2).

Since the complex behavior of both markets precludes a detailed analysis of their behavior, market trends will be emphasized. Particular attention will be directed toward the market conditions that precipitated major U. S. program legislation.

Figure 3 is a graphical representation of U. S. supply and disappearance for the period, 1945-1969. Supply is defined as production plus the carryover from the

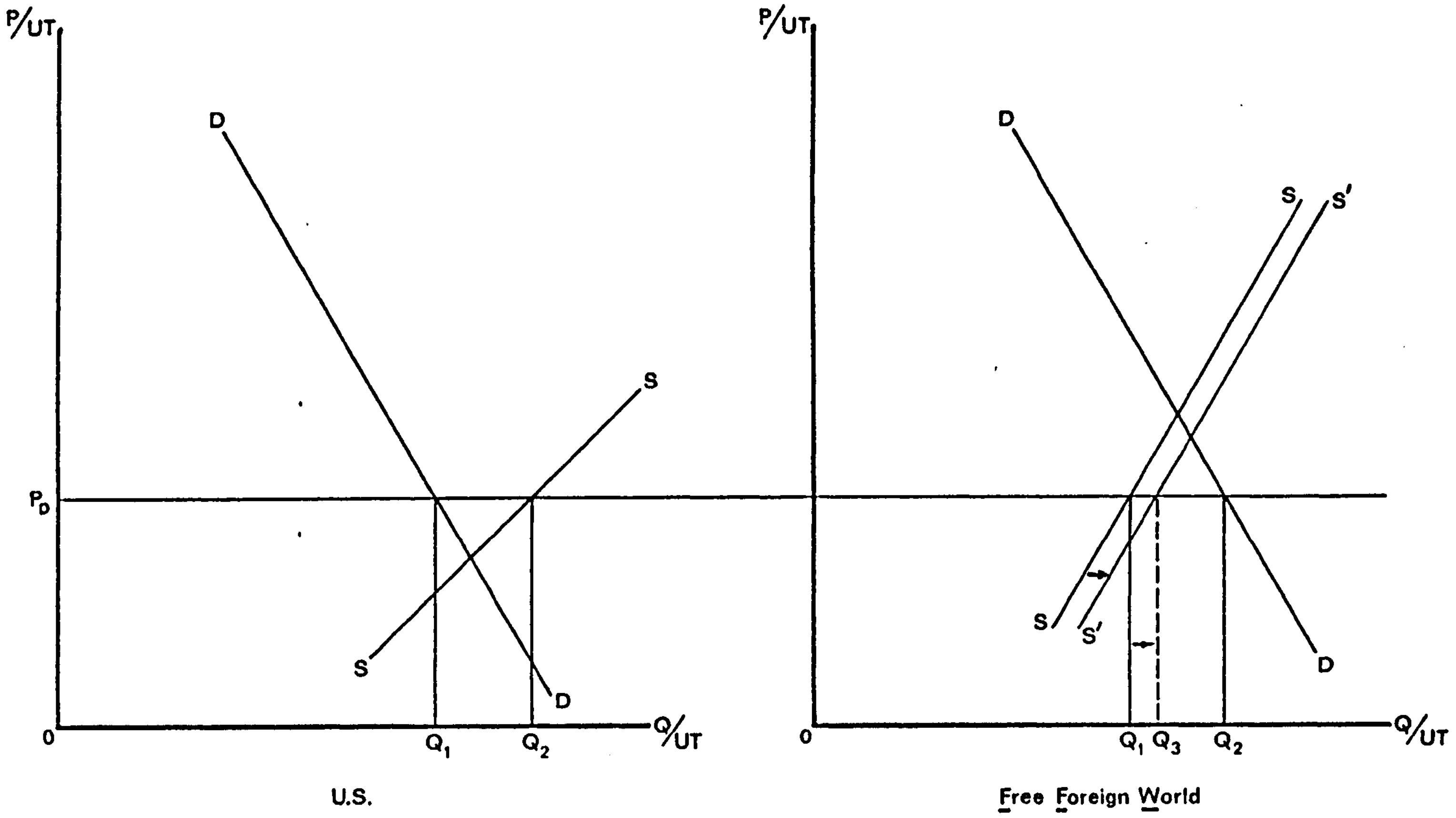


Figure 2. Two-Sector Market Model Depicting Market Situation for Cotton at Close of World War II

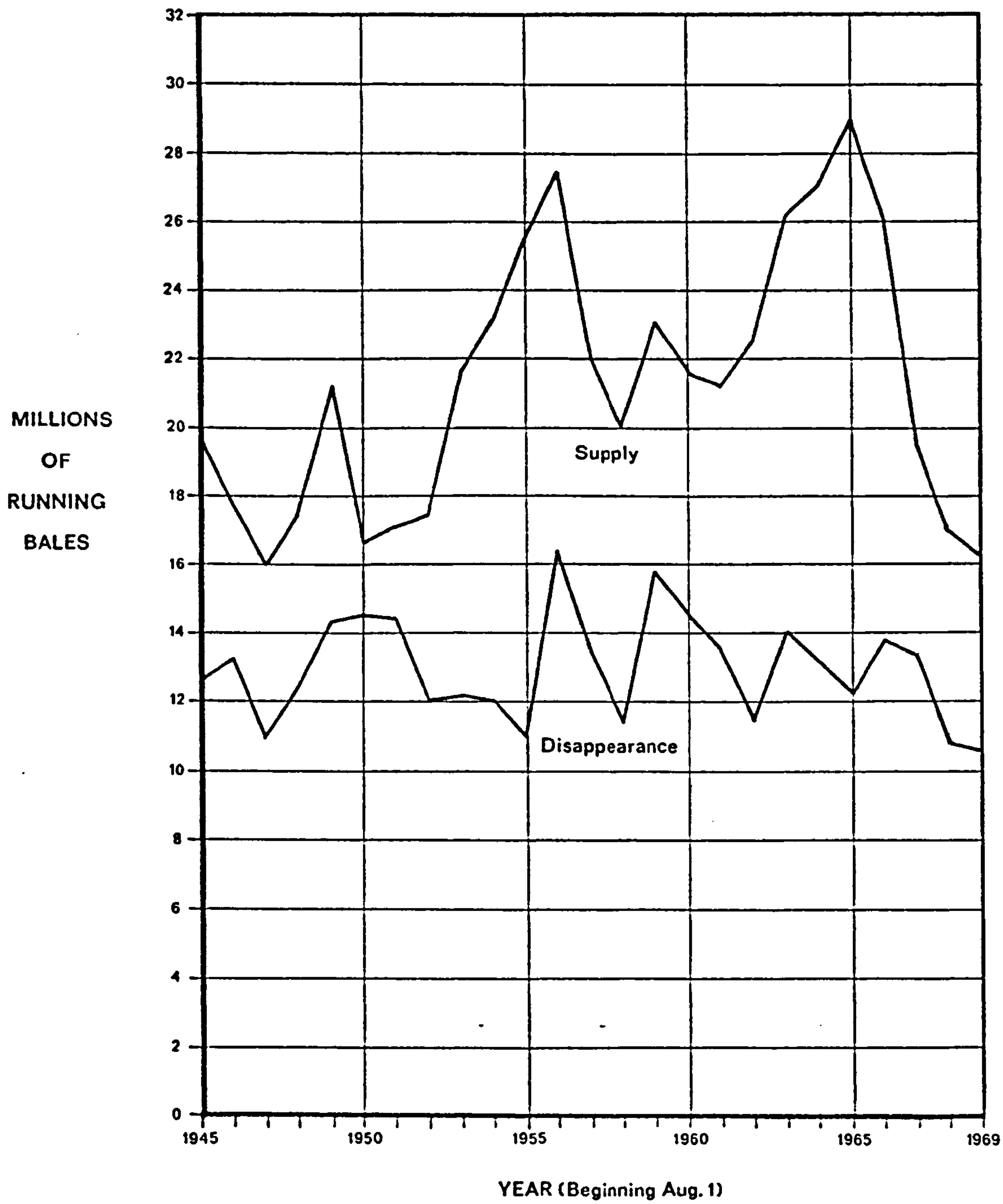


Figure 3. Supply and Disappearance Trends for Upland Cotton, 1945-1969 -- Source: Table 2.

previous year's supplies. Disappearance is the sum of the two components shown in Figure 4, exports and domestic mill consumption. The vertical difference between the supply line and the disappearance line in Figure 3 is the carry-over stock for the following year.

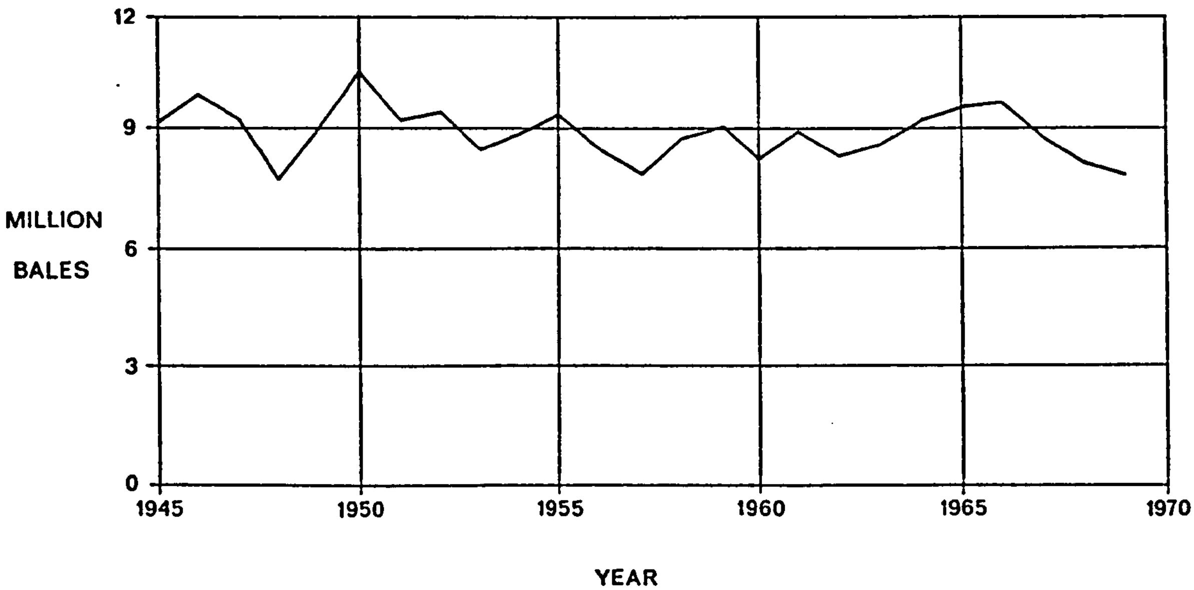
Figure 5 shows the average price/pound received by U.S. farmers for upland cotton from 1945-1969 and the average annual price for a specified grade of U.S. cotton in the Liverpool market from 1953 to 1969. The Liverpool price is regarded as the FFW market price for U.S. upland cotton.

Table 1 lists the average seasonal price for U.S. upland cotton and the average payment and subsidy levels to U.S. growers, domestic users, and exporters throughout the period 1949-1970.

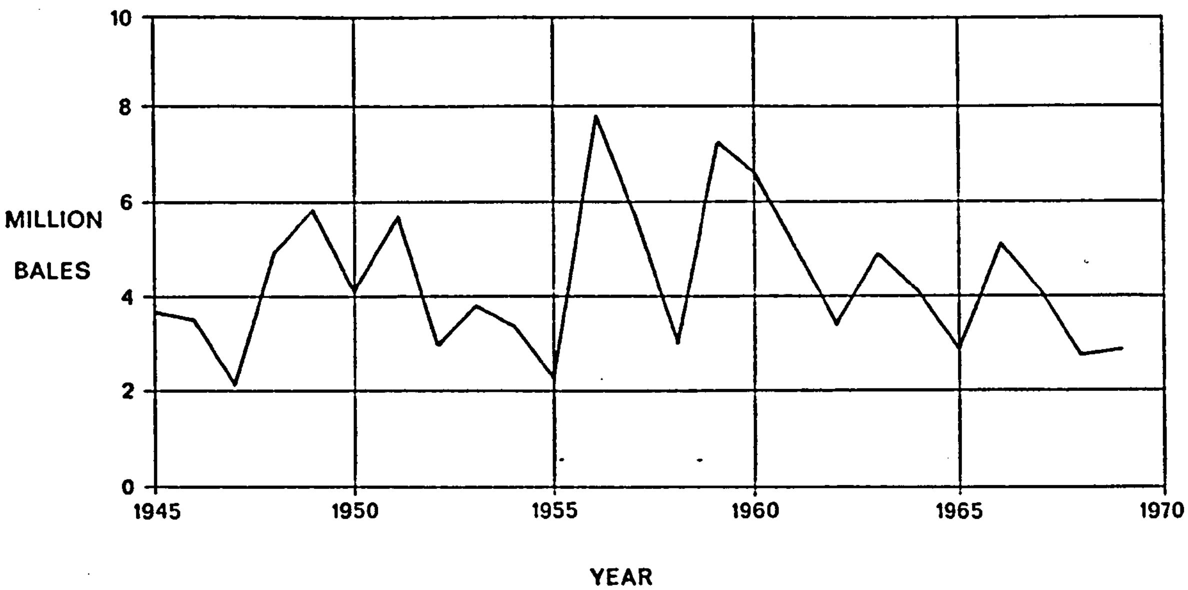
Table 2 summarizes numerical data for supply, disappearance, carryover, domestic mill consumption, exports, and Liverpool price.

The Early Years, 1945-1955

At the close of World War II, the market conditions for cotton were similar to the situation illustrated by the model in Figure 2. Production-stimulating measures of the war years, including the absence of controls and high price-support levels, were continued during the period 1945-1949. The high world price stimulated production throughout

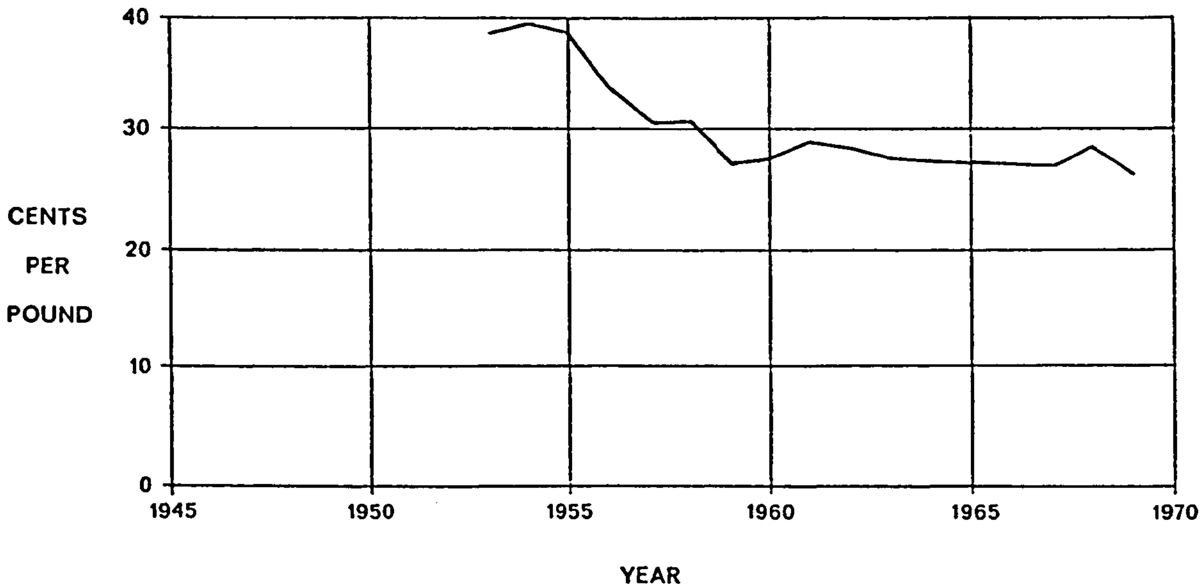


Mill Consumption of Cotton in the United States, 1945-1969
-- Source: Table 2.

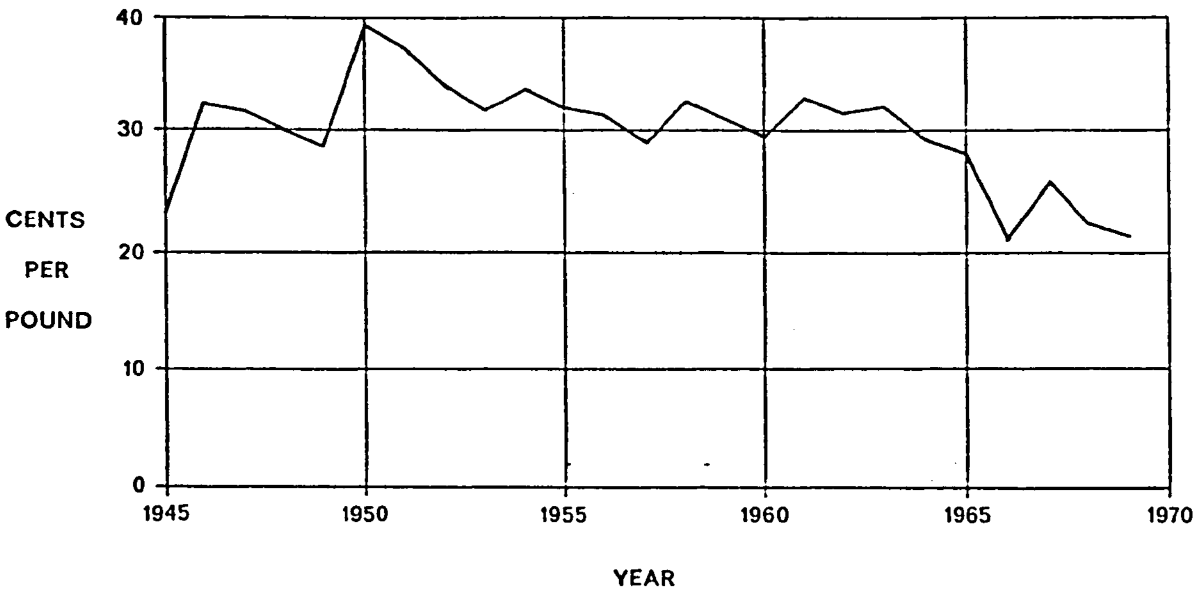


Exports of Cotton from the United States, 1945-1969

Figure 4. U. S. Mill Consumption and Exports, 1945-1969 -- Source: Table 2.



Average Annual Price, 1"M, CIF, Liverpool, England, 1953-1969



Prices Received by Farmers for Cotton in the United States, 1945-1969

Figure 5. U. S. and World Price Levels -- Source: Table 1.

Table 1. Per-Pound Price and Subsidy Rates for U. S. Upland Cotton, 1949-1970

Year	Season Average Price	Subsidy Payment Rate for Exports	Domestic Subsidy	Support Payment Rate
	(cents/pound)			
1949	28.57			
1950	39.90			
1951	37.69			
1952	34.17			
1953	32.10			
1954	33.52			
1955	32.57	7.50[a]		
1956	31.63	7.21[a]		
1957	29.46	6.19[a]		
1958	33.09	6.50		
1959	31.56	8.00		
1960	30.08	6.00		
1961	32.80	8.50		
1962	31.74	8.50		
1963	32.02	8.50		
1964	29.62	6.50	6.50	3.50[b]
1965	28.03	5.75	5.75	4.35[b]
1966	20.64			9.42
1967	25.39			11.53
1968	22.02			12.24
1969	20.60			14.73
1970				16.80

[a]Difference between CCC export sale price and average price for middling 1-inch cotton in the designated spot markets.

[b]Paid to small producers and domestic allotments only.

Source: United States Department of Agriculture, Economic Research Service. Cotton Production and Farm Income Estimates Under Selected Alternative Farm Programs, Agricultural Economics Report 212, Strickland, P. L., et al., Washington, D. C., 1971 (Table 3, p. 7).

Table 2. Some Statistical Series on U. S. Upland Cotton

Year	Disappearance[1]	Carryover[1]	Supply[1] (Carryover plus Production)	Upland Mill[2] Consumption	Exports[3]	Price 1"[4] Middling CIF Liverpool
	(1,000 bales)					(cents/pound)
1945	12,650	11,006	19,815	8,946	3,613	
1946	13,288	7,165	15,680	9,755	3,544	
1947	10,960	2,392	13,948	9,101	1,963	
1948	12,349	2,988	17,565	7,629	4,746	
1949	14,376	5,216	21,121	8,666	5,771	
1950	14,447	6,745	16,591	10,452	4,108	
1951	14,461	2,144	17,170	9,011	5,515	
1952	12,089	2,709	17,567	9,280	3,048	
1953	12,181	5,478	21,731	8,439	3,760	38.42
1954	12,128	9,550	23,127	8,705	3,445	39.13
1955	11,118	10,999	25,500	8,987	2,214	38.91
1956	16,233	14,382	27,484	8,591	7,598	33.17
1957	13,459	11,251	22,052	7,855	5,717	30.62
1958	11,227	8,592	19,945	8,535	2,789	30.48
1959	15,774	8,718	23,164	8,854	7,182	26.92
1960	14,511	7,390	21,589	8,084	6,632	27.03
1961	13,616	7,078	21,341	8,863	4,915	28.81
1962	11,474	7,725	22,479	8,198	3,351	28.62
1963	14,024	11,005	26,134	8,384	5,662	27.29
1964	13,124	12,110	27,142	9,000	4,060	26.96
1965	12,300	14,018	28,866	9,338	2,942	26.75
1966	13,786	16,565	26,056	9,298	4,669	25.40
1967	13,390	12,270	19,637	8,923	4,206	25.71
1968	10,738	6,246	17,085	8,067	2,731	28.22
1969	10,605	6,347	16,214	7,838	2,768	25.53

Sources: 1. United States Department of Agriculture, Economic Research Service, Statistics on Cotton and Other Related Data, Statistical Bulletin 329, Washington, D. C., April 1963 and supplements, Table 100, p. 99.

2. Ibid., Table 12, p. 11.

3. Ibid., Table 9, p. 8.

4. Ibid., Table 240, p. 215.

the world, and increased supply levels in the FFW sector reduced the size of the available export market as shown by S'S' in Figure 2.

In the United States, a sharp reduction in acres planted resulted from the imposition of acreage controls under the price-support program for the 1950 crop. Reduced supplies, coupled with increased domestic demands brought on by the Korean conflict, caused a sharp rise in market prices, thus temporarily obscuring the U.S. cotton surplus problem. High price-support levels were continued and acreage limitations were relaxed during the period 1951-1955, despite overall declines in domestic mill consumption and exports (see Figure 4). The result of this combination of circumstances is shown in Figure 3, where disappearance declined and supply (production plus carryover) increased during this period.

Public Law 480 was passed in 1954. Although this legislation did not directly affect cotton support prices, it did list among its objectives the stimulation of exports of agricultural commodities, including cotton. Despite the program, the downtrend in cotton exports continued. In 1955, exports fell to their lowest level since 1947 (see Table 2). Total carryover stocks climbed to over 11 million running bales in 1955, with 9.6 million bales being held in public storage by the government (see Table 2).

Trial and Error, 1956-1965

The Agricultural Act of 1956 represented a significant legislative effort to cope with the cotton surplus problem. Faced with adverse supply and demand conditions, the government offered an export subsidy, reduced price-support levels, and called for reductions in crop acreage.

Prior to the legislation (pre-1956), supply and demand levels in both market sectors took on the characteristics illustrated by the model in Figure 6. Despite the need for downward price or supply adjustment designed to bring production into balance with consumption, the U.S. maintained price level P_s for the 1955 crop year. At this price level, the U.S. was generating annual excess supplies of Q_1Q_2. The FFW market had an annual excess demand equal to Q'Q", a substantially smaller quantity than the U.S. excess supply of Q_1Q_2 at this price level.

The 1956 program sought to reduce supply levels with the establishment of a "Soil Bank," a feature designed to divert allotment acreage into soil-conserving uses. This action is represented by a shift to the left in the supply curve from SS to S'S' in Figure 6. This has the effect of reducing excess supply levels from Q_1Q_2 to quantity Q_1Q_3.

The second provision of this program was a reduction in price-support levels. The effects of this action on quantities of excess supply and excess demand can be

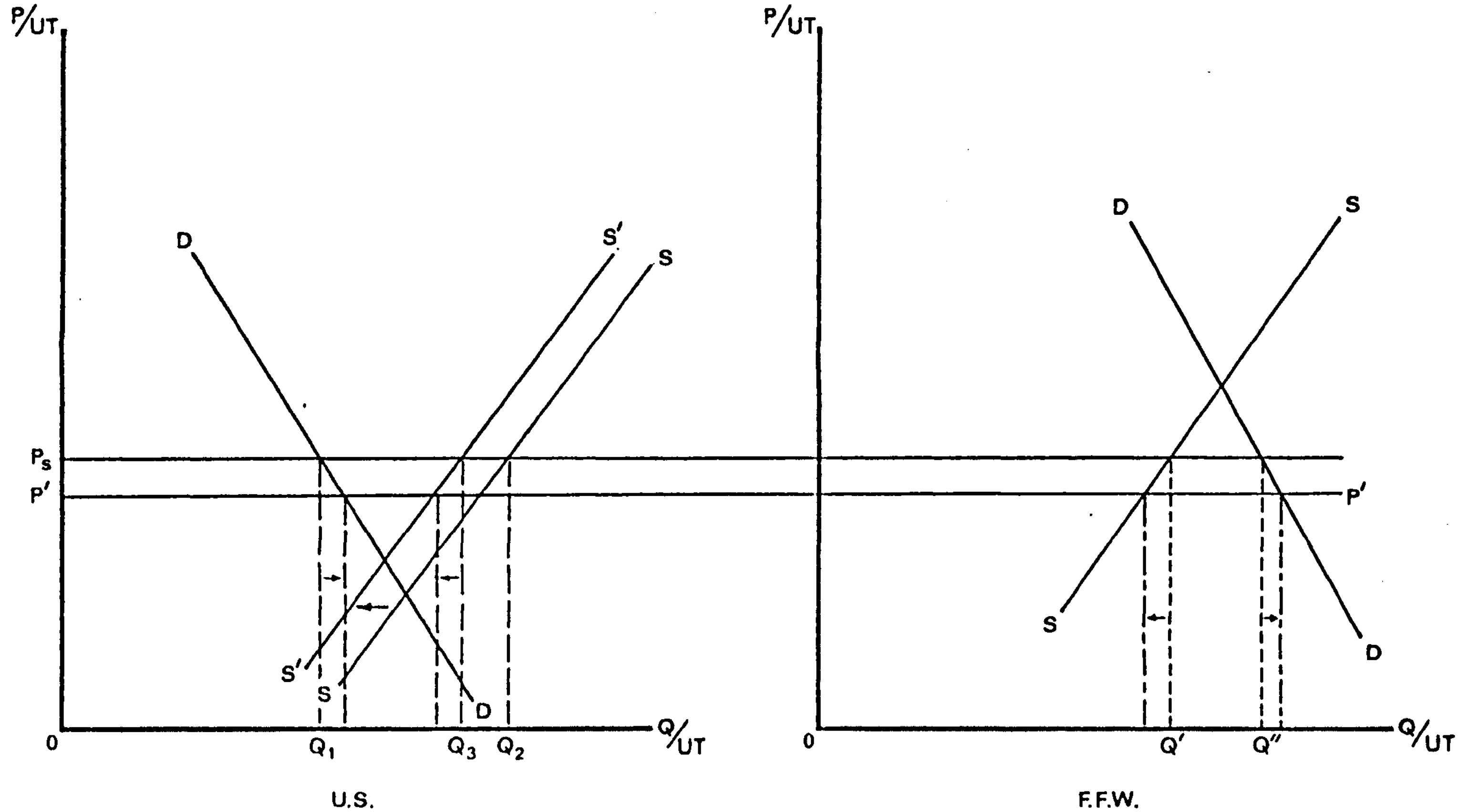


Figure 6. Effects of 1956 Program Legislation on Upland Cotton Markets

demonstrated with the model in Figure 6. A movement in price level from P_s to P' increases the quantity of excess demand in the FFW sector to something greater than Q'Q", while reducing the quantity of excess supply in the U.S. market to something less than Q_1Q_3.

For the purpose of reducing surplus stocks, an export subsidy provision was included in the program legislation. The subsidy effectively lowered the price of U.S. cotton in the FFW market. The effects on the FFW sector are the same as previously discussed price level reduction effects. An export subsidy has no direct effect on the U.S. market price in this model as long as the export subsidy does not cause excess demand in the FFW sector to exceed the excess supply in the U.S. market sector at the given price-support level.

The results of the 1956 program conform quite closely to what the model would predict. U.S. price and supply levels declined (see Figures 3 and 5), and exports increased sharply, reaching 7.6 million bales in 1956 (Table 2). Carryover stocks were reduced from the record August 31, 1956, level of 14.4 million bales to 11.3 million bales in 1957 (Table 2).

By 1960 the national cotton situation had improved substantially from the 1955-1956 surplus crisis. Except for a slump in 1958, exports exceeded 6 million running bales in each year of the period 1956-1960, as is shown in

Figure 4. The surge in production levels that accompanied the return to regular allotments for the 1959 crop year was absorbed by the strong export market. Price-support levels were raised in 1960, and the stage was set for a replay of what occurred during the early 1950's. The higher price level encouraged production throughout the world, increasing supply levels in both the U.S. and FFW sectors. Despite the continuation of an export subsidy, the export market for U.S. cotton weakened with effects similar to those shown by the model in Figure 2. Excess supply levels increased in the U.S. market and excess demand levels in the FFW market declined. By 1965, total carryover stocks had increased to a level of 14 million running bales. This trend continued and carryover stocks reached a record 16.56 million running bales in 1966 (Table 2). Disappearance declined in 1964 and 1965 (Tables 1 and 2), despite the existence of a direct subsidy to domestic cotton users and cotton exporters.

The Food and Agriculture Act of 1965

In an effort to alleviate the surplus problem, Congress passed The Food and Agriculture Act of 1965. This legislation called for a sharp reduction in U.S. market price to encourage domestic consumption and to provide incentives for producers to cut back on production. The Food and Agriculture Act of 1965 provided for a reduction in the national acreage allotment for upland cotton to a minimum of 16 million acres.

The magnitude of the price drop resulting from the substantial cuts in price-support levels is shown by the statistics in Table 1. With the price-support level effectively lowered below market price levels, the need for subsidies for exporters and domestic consumers was eliminated.

To compensate for the loss of farm income due to the low price-support level, the program provided for direct payments to producers based on the expected production of sixty-five per cent of each grower's regular allotment acreage. This portion of the allotment was designated as domestic allotment. Participants in the program were required to divert not less than 12.5 per cent, but could divert up to thirty-five per cent, of their regular allotment acreage from production and earn additional government payments for their diverted acreage.

In the early years of the program, the combination of low price-support levels and attractive diversion payments prompted many growers to restrict their planted acreage to their domestic allotment, which was the required minimum planted acreage for full participation in the program. In addition to this decrease in planted acreage levels to approximately sixty-five per cent of the regular allotment, per-acre yields declined sharply because of adverse growing conditions. Total production was reduced significantly in 1966.

Low price levels sharply curtailed U.S. cotton growers' enthusiasm for planting their full cotton allotments. Many growers planted only ninety per cent of the domestic allotment (sixty-five per cent of the total allotment), which qualified them for their maximum allowable diversion payment in addition to their price-support payment.

The effects of reduced price levels for U.S. cotton and a decline in U.S. supply levels can be shown with the two-sector model in Figure 7. It can be seen that, if the U.S. demand had remained constant, U.S. stocks would not only have rapidly declined, but also there would have likely been higher market prices and expanding U.S. production by 1970. During this period, U.S. demand was drifting to the left because of displacement by man-made fibers and part of the potential benefit of the 1965 program was cancelled out.

Aside from direct payments, the government's role in the market was reduced by the 1965 legislation. The program replaced the domestic user and export subsidy programs with a direct payment to the grower. The direct payment aspect of the program drew sharp criticism. It was argued that payments to large producers were not justifiable from an income maintenance standpoint.

Consequently, for the first time, program legislation for the 1971-1973 crops placed limits on the magnitude

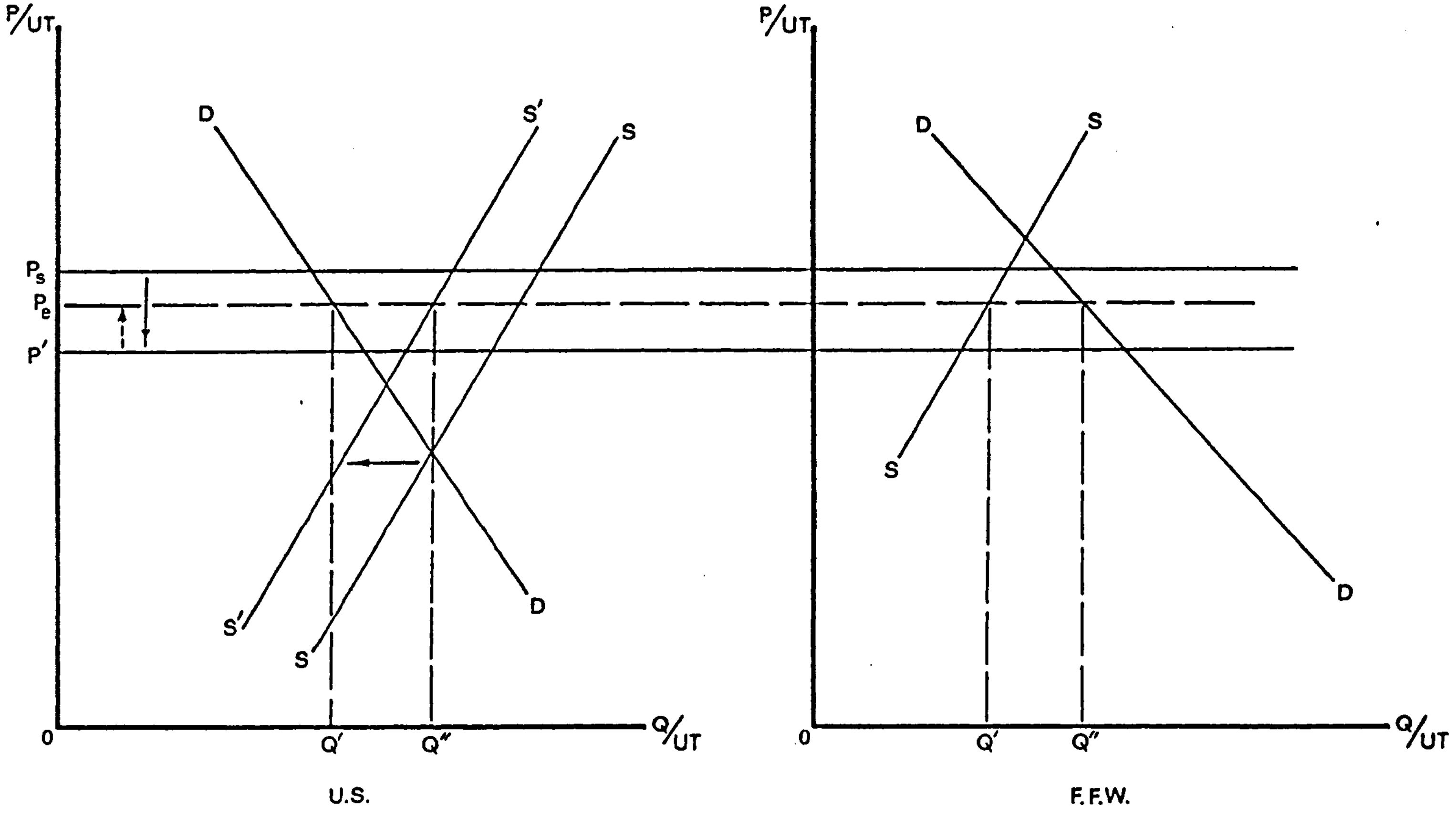


Figure 7. Effects of a Substantial Reduction in Price-Support Level and U.S. Supply Level

of direct payments at $55,000 per commodity per producer. Except for this provision for payment limitations, the 1970 legislation is in its effects essentially the same as the 1965-1970 program.

Summary

Since 1945, cotton has become less competitive in domestic and foreign fiber markets. Ultimately the price level for cotton is a function of market supply and demand conditions. It is apparent that cotton prices should weaken in a market characterized by increasing supply levels and declining demand levels, and declining prices bring about declining farm income levels.

For various reasons, U.S. policy-makers have elected to maintain farm income via price-support programs. The criteria for setting price-support levels can be faulted for not recognizing changes in input and productivity relationships. Consequently, price-support levels have been excessively high, stimulating increased production and leading to excessive supply levels instead of adjusting supplies downward as demands slackened.

When unmanageable surpluses accumulate, sharp downward price adjustments and supply level adjustments in the form of allotment reductions are necessary. The 1965 program of legislation was such a measure. More significantly, the program represented a substantial departure from the basic price-support policy of the earlier programs. Rather than attempting to define a new market equilibrium at some relatively high price-support level, the program limits acreages to hold U.S. supply levels in check, while maintaining farm income through direct payments to producers. The imposition of payment limitations may portend a further withdrawal of government influence in the market by reducing the support of farm income levels for cotton producers.

This study is concerned with some of the effects that this program may have on Arizona allotment values and the organization of the cotton industry.

CHAPTER III

ALLOTMENT VALUE: A LOGICAL CONSEQUENCE OF PRICE-SUPPORT PROGRAMS

Allotment value is an empirical fact; farms with cotton allotments command higher sale prices than comparable farms sold without allotments. A logical explanation exists for this phenomenon.

The allotment represents a right to participate in government cotton programs and receive whatever benefits the programs provide.

The allotment can be viewed as an income-producing asset. The values of such assets are commonly determined by the capitalized annual income stream that the assets provide for the owners. The magnitude and potential duration of the benefit forms the basis for allotment value. The most general capitalization formula for the asset value assumes that the annual income flow is constant and known with certainty into perpetuity. The formula is:[2]

$$V = \frac{R}{r} \qquad \text{(I)}$$

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2. E. O. Heady, Economics of Agricultural Production and Use (New York: Prentice-Hall, 1952), p. 396.

In this formula, the annual income is represented by R, the market rate of interest is r, and the present value of the asset is V. Extraordinary risk can be compensated for by inflating the value of r.

Where uncertainty necessitates that future planning be limited to a finite number (t) of production periods (years), the basic capitalization formula is modified to a discount formula and expressed as follows:[3]

$$V = \frac{R_t}{(1 + r)^t} + \ldots + \frac{R_T}{(1 + r)^T} \quad t = 0 \ldots T \qquad \text{(II)}$$

Assuming that R and r are constant, the value of V will be smaller in Formula II than in Formula I if T is less that infinity.

Fluctuations in R that can be anticipated with certainty can be discounted with Formula II. It should be apparent that lower values of R bring about lower values for V, all else being equal.

The value of allotment acreage can be estimated with the discount formula, if R, r, and T are known. In this context, the economist defines income (R) as the residual income remaining after all other factors of production have been paid their acquisition cost or alternative use value.

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3. *Ibid.*, p. 386.

Per-acre yields can be easily estimated, which leaves price as the critical variable in determining gross income. To the extent that the government stabilizes price through commodity programs, gross income is correspondingly stabilized as long as there has been no previous inverse correlation of price and quantity. Assuming that costs are relatively stable, income above costs (R in the discount formula) can be estimated. Futhermore, cotton programs guarantee income levels (R) via price-support levels for some specified length of time (T in the formula).

Thus, the owner of the allotment implicitly attaches some value (V) to the allotment based upon his knowledge of the values of R, r, and T, with R and T being functions of the existing program legislation.

The Influence of Government Programs on the Value of R

Given the knowledge of how an income stream becomes capitalized (or discounted) into an allotment value, it is of interest to examine how the magnitude of that income stream (R) is influenced by changes in government programs.

By using a per-unit cost and revenue model for an upland cotton allotment acre (see Figure 8), it is possible to analyze the effects of price-support level changes, allotment size changes, direct subsidy payments, and limitations on direct subsidy payments with respect to per-acre residual income (R in the discount formula).

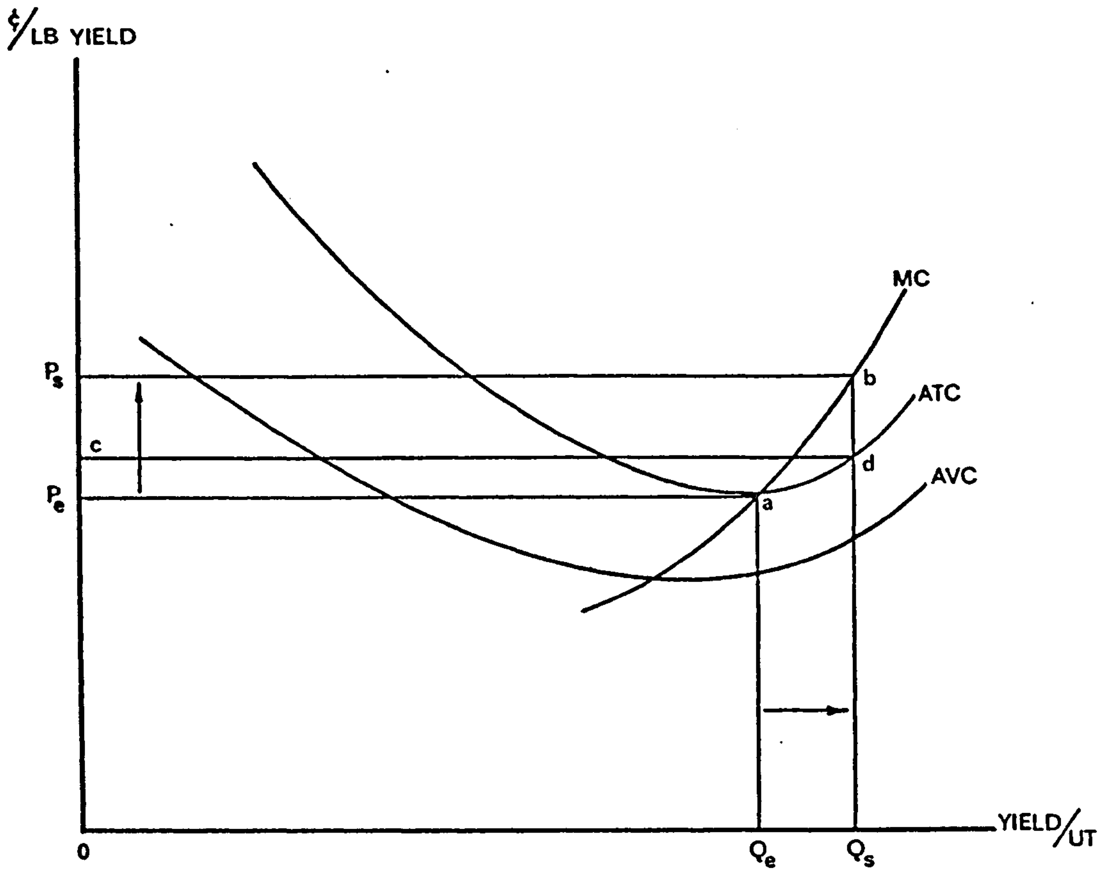

Figure 8. Typical Cost Relationships for an Acre of Upland Cotton Allotment

Cotton is sold in a competitive market and the individual cotton producer cannot influence the price for a given quality of cotton. Relevant costs in the model are average variable costs, average total costs, and marginal cost.

For a typical acre of upland cotton allotment, the per-unit cost curves would look like the curves shown in Figure 8. The horizontal axis represents production in pounds, and the vertical axis is the price or cost in cents/pound.

Marginal cost (MC) is the cost associated with each additional pound of production. Rational behavior dictates that a producer will produce at an output where MC equals price in the short run, as long as price is equal to or greater than average variable costs. Average total cost (ATC) is the sum of average fixed costs and average variable costs at a given output level.

The government, however, has chosen to influence cotton prices for the purpose of maintaining farm income levels. From 1954 to 1965, this influence was in the form of price supports.

At some hypothetical support price (P_s) above the equilibrium price (P_e), the grower expands output to a higher level Q_s. Although the total cost of production increases as a result of this expanded production (from OP_eaQ_e to $OcdQ_s$), it is more than compensated for by the larger gross income (OP_sbQ_s) that can be realized. The gross income in excess of total costs is defined as net income. Such an anticipated net income stream, discounted to the present moment, represents the allotment value.

Program changes which alter the level of the support price (P_s) bring about altered production levels at which price equals marginal cost (MC). Net income levels are correspondingly affected, leading to changes in allotment value.

Adjustments in the size of the national allotment base effectively shrink or expand the size of our hypothetical allotment acre. Shifting the cost curves to the right in the model depicts the effects on net production and net income that would result from an expansion of the allotment base. The effects of a reduction in the allotment base can be shown by shifting the curves to the left.

Federal programs for the 1966-1970 cotton crops provided direct price-support payments on a portion of the allotment's production, as compensation for the lowered price-support levels. As pointed out in Chapter II, the lowered price-support level dampened the growers' enthusiasm for planting acreage which could not qualify for the subsidy payments. The effects on income levels and production for allotment acreage qualified to receive subsidy payments can be illustrated with the model shown in Figure 9.

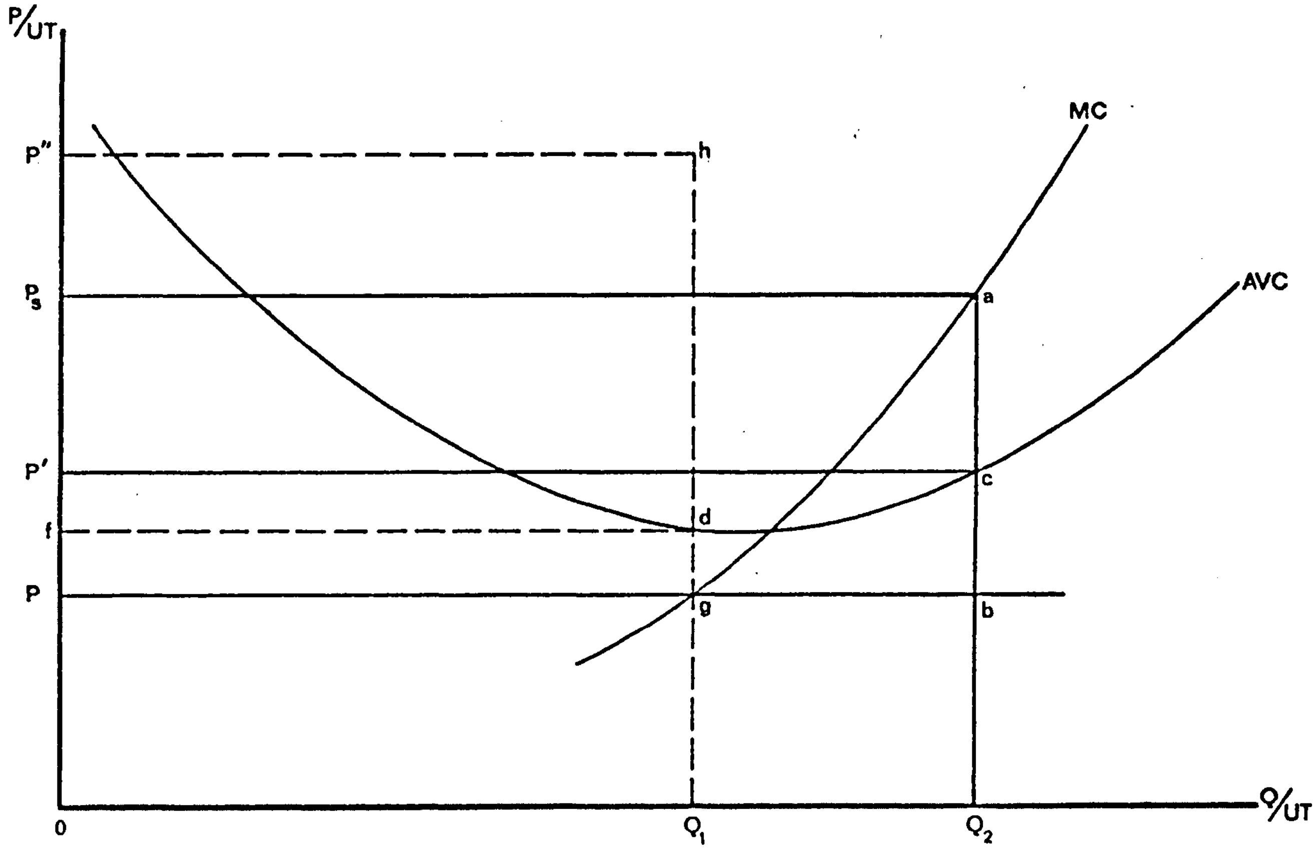

Figure 9. Cost and Income Relationships for an Acre of Domestic Allotment Under the 1966-1970 Program

Price level P_s represents a hypothetical "high" price level for cotton under pre-1966 programs. At price level P_s, production is OQ_2 (where price and marginal revenue equal marginal cost). Assuming as one extreme case that the government fixed the projected yield at OQ_2 at the inception of the 1965 program and provided a fixed per-pound subsidy payment rate of PP_s to augment the lower price-support level of P, then the grower can expect to receive a total subsidy payment equal to $P_s$abP for the duration of the program. The program required that production be carried out on ninety per cent of acres qualifying for payment in order to receive the full subsidy payment. If the grower continues to produce at OQ_2, he incurs a loss of P'cbP and realizes a net income of $P_s$acP'. It is clear that the producer could lower his total costs by reducing output to something less than OQ_2 and still receive a total subsidy payment based on OQ_2, assuming that projected yield is fixed at OQ_2. The optimum production level under these conditions is OQ_1, which minimizes losses on production (fdgP). This minimum loss balanced against a fixed total subsidy income $P_s$abP, shown as P"hgP in the model, leaves a maximum residual income to the allotment acre of P"hdf. This income stream is for a domestic allotment acre that qualifies for payments. Thus, the income and, ultimately, the value of a regular allotment acre would be sixty-five per cent of the income and value of a domestic allotment acre.

Relaxing the assumption that projected yield is fixed at OQ_2 alters the size of the total subsidy payment. As the second extreme case, assume that the payment is based on actual yield in the same year and the per-pound subsidy rate is constant at PP_s. In this situation, production levels will revert to OQ_2, the same level as when price-support levels are pegged at P_s for an acre of domestic allotment. Income and value for a full acre of allotment will again be sixty-five per cent of that income and value associated with an acre of domestic allotment.

The program defines projected yield as a moving three-year average of the allotment's actual yield. At the outset of the program, a producer would be tempted to restrict his production to OQ_1 and receive a payment based on his projected yield of OQ_2. However, this would reduce the size of his total subsidy payment in the following year, and, all else being equal, would mean a loss of net income. Maintaining a production level of OQ_2 would be an optimal solution only if the payment were based on actual production in the same year or in the case where the rate of payment is expected to continue into the indefinite future and the discount rate of future earnings is zero.

Faced with uncertainty regarding future programs, it is reasonable to suggest that producers elected to maintain production and projected yield values nearer OQ_2 than OQ_1 early in the program. As the program neared its end, producers probably tended to restrict production to a level closer to OQ_1. In either case, the program offers benefits substantial enough to provide a net income stream which becomes capitalized into an allotment value. Also, the lower price expectations are probably a significant factor in explaining the decline in per acre cotton yields that have been observed in recent years.

Should an acre of domestic allotment fail to qualify for payments because of the 1971 provision for payment limitations, the producer faces a price of P and no hope of deriving any positive net income. With a negative net income stream, the allotment ceases to be of positive value (i.e., $V = \frac{0}{r} = 0$) while retained in the original owner's control.

This chapter has explored some theoretical relationships among programs, prices, income, and allotment value. The following chapters are concerned with exploring the empirical relationships between income and allotment value for allotment acreage in central Arizona. The potential effects of payment limitations on allotment income and farm organization in Arizona will also be explored.

CHAPTER IV

ESTIMATION OF THE PER-ACRE VALUE OF UPLAND COTTON ALLOTMENTS IN CENTRAL ARIZONA

The purpose of this chapter is to empirically estimate the per-acre values of cotton allotments in central Arizona.

The hypothesis that upland cotton allotments have a capitalized value was tested in work completed by Howard Barfels in 1967.[4] Barfels applied multiple regression analysis to historical sales data to explore relationships between selected independent variables and the sales values of farms. This research confirmed the existence of substantial values associated with upland cotton allotments in the early 1960's.

The Food and Agriculture Act of 1965 allowed the transfer of allotments exclusive of land. However, allotments sold in conjunction with farmland would be expected to have some value that would be reflected in the sale price of the farm.

By developing appropriate regression models, it should be possible to obtain estimates for the per-acre

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4. Howard R. Barfels, "The Value of Cotton Allotments in Arizona," unpublished Master's Thesis, The University of Arizona, Tucson, Arizona, 1967, p. 2.

value of central Arizona upland cotton allotments in any given year. The regression coefficients associated with independent variables in the models can be interpreted as marginal values for the variables. The specific objective of this analysis is to develop marginal value estimates for annual allotment values during the period 1961-1967. These estimates will be compared to annual income estimates obtained with budgetary analysis techniques.

Source of Data

The Western Farm Management Company in Phoenix maintains files on individual sales of rural property in Arizona that it uses as background information for preparing farm appraisals. Their files were an excellent source of primary data for sales that occurred during the period 1961 through 1968. Information on the location of a parcel, its upland allotment acreage, its total acreage and land use classification, total price, water supply, value of improvements, and date of sale were obtained from these files.

Data Preparation

The only sales that were included in this analysis were sales of rural farmland that had cotton allotments attached to them. Furthermore, sales had to be "bona fide" transfers of assets. Any cases where it was determined that the price paid did not solely represent payment for the land and its associated use were not included.

Examples of this are transfers of estate property between family members, sales of state lease land to tenants with a long history of occupancy, and condemnations for public ownership.

Initial examination of the data indicated that information was available on relatively few sales of property in Pinal County during the first few years of the period 1961-1968, which made it unsuitable for analysis as a separate area. Pinal County observations could have been included with Maricopa County sales, but again, examination of the data indicated a wide divergence in sale value for farmland between the two counties. In light of this, it was decided that all analysis would be done with sales of farmland in Maricopa County.

Because of limitations with respect to our ability to observe and classify variables, it was necessary to define variables that would reflect influences on property value of other variables that could not be easily quantified. It was expected that improvement value was a variable that would substantially affect sales prices. This variable was expressed as a "0, 1" variable in the models. Where the sales reports indicated that the value of improvements on a specific farm were substantially above normal for farms of similar size, this variable was given a value of "one." A similar variable was defined for below-normal improvement values.

Water is essential for agricultural production in the cotton growing areas of Arizona, and the conditions of its availability would be expected to be an important variable in determining the sale price of a farm. Barfels attempted to express water supply in terms of the cost per acre-foot in his work. In addition to cost, however, quality and dependability of supply are important factors in determining the relative desirability and value for various water sources.

Ideally, each water district and pumping field should be treated as an independent variable. Because of the limited number of sales in any given district, meaningful statistical results could not be obtained using this approach. Therefore, water supply was expressed as three "0, 1" variables. Each water district was reviewed with respect to cost per acre-foot, quality, and dependability of supply, and was assigned to one of three classifications: good (Salt River Project), fair (Roosevelt Irrigation District), and poor (well water). (See Appendix, Table 10, for classifications.)

Speculative value, or the potential for shifting the use of the land for purposes other than farming, was expected to exert a strong influence on property values. Urban development is the major speculative factor in Maricopa County. Although difficult to quantify, the speculative influence would be expected to be correlated with the location of the property. A location variable was included and expressed simply as the distance in miles from the city limits of metropolitan Phoenix to the specific land parcel.

The removal of the effects of abnormal improvement levels, water supply conditions, and speculative influences on sale price is necessary to isolate the influence of allotment acreage and net crop acreage on sale price, which is of primary interest in this analysis. The problem of isolating the effects of specific variables is readily dealt with by using multiple regression techniques.

Net crop acreage in this analysis is defined as crop acres less allotment acres. This means that an allotment acre, as defined here, includes the rights under the government program to plant an acre of cotton and also an acre of land suitable for growing cotton. By treating these variables in this way, it may be possible--by a process explained later in the chapter--to estimate the value of an acre of allotment as distinct from an acre of land that may be part of the same farm sale price. One acreage variable was defined for each year that had sales data recorded by the source.

Analytical Procedure

Two basic series of multiple regression models were used in this analysis. The primary difference between the models was the form of the dependent variable:

Series I Y_1 = $/A: The average sale price per acre for the parcel.

Series II Y_2 = $: The total-dollar sale price of the parcel.

Independent variables included in both series of models are defined below:

D - The distance in miles of each parcel from the city limits of metropolitan Phoenix.

SS - (61-68) That part of the parcel which is upland cotton (i.e., short-staple) allotment.[5]

NC - (61-68) Net crop acreage in parcel.[5]

NNC - (61-68) Non-cropland acreage in parcel. The residual after subtracting net crop acres and upland allotment acres from the total acreage in the parcel.[5]

5. Variable is expressed as a percentage in Series I models and as actual number of acres in Series II models. Subscript denotes year in which acreage was sold, with each year represented by an individual variable.

Pos - Improvement valuation is substantially above normal for a farm, all else being equal; expressed as a "zero-one" variable.

Neg - Improvement valuation is below normal for a farm, all else being equal; expressed as a "zero-one" variable.

SRP - Good water supply, expressed as "0, 1."

RID - Fair water supply, expressed as "0, 1."

Well - Poor water supply, expressed as "0, 1."

a - Constant term which embodies the net influence on the dependent variable of variables not explicitly included in the model.

The significance of coefficients associated with the independent variables was judged by the following statistical tests:

1. The "t" test was used to evaluate the significance of estimated regression coefficients. Computed "t" values appear in parentheses below each regression coefficient. Significance at the five per cent and ten per cent level is denoted by ** and *, respectively.
2. The coefficient of multiple determination (R^2) gives a measure of the proportion of the variation in the dependent variable that is explained by variation in the independent variables.

An initial Series I model which included all of the above variables was tested.

This model suggested that the coefficients for all NNC variables were not significant, as well as the SS_{68} and C_{68} variable coefficients. These variables were not included in subsequent models, thus eliminating 1968 from the analysis.

Investigation of the Distance Variable

The residuals from this initial regression suggested that the relationship between sale price and the independent variable representing distance was not a linear function.

In order to better identify the influence of distance, this variable was next expressed as a logarithm and then as the reciprocal of the distance. The water supply variables were deleted from these models because of the high positive intercorrelation between the independent variables of "D" and "SRP."

When graphed, the functions described in the two models coincided at a point 15 miles from the metropolitan Phoenix city limits. The values for the dependent variable were then plotted on the same graph in order to determine which form of the distance variable best measured this empirical relationship (see Figure 10). From zero to fifteen miles, the logarithmic function was a better estimate; the reciprocal function gave a better fit

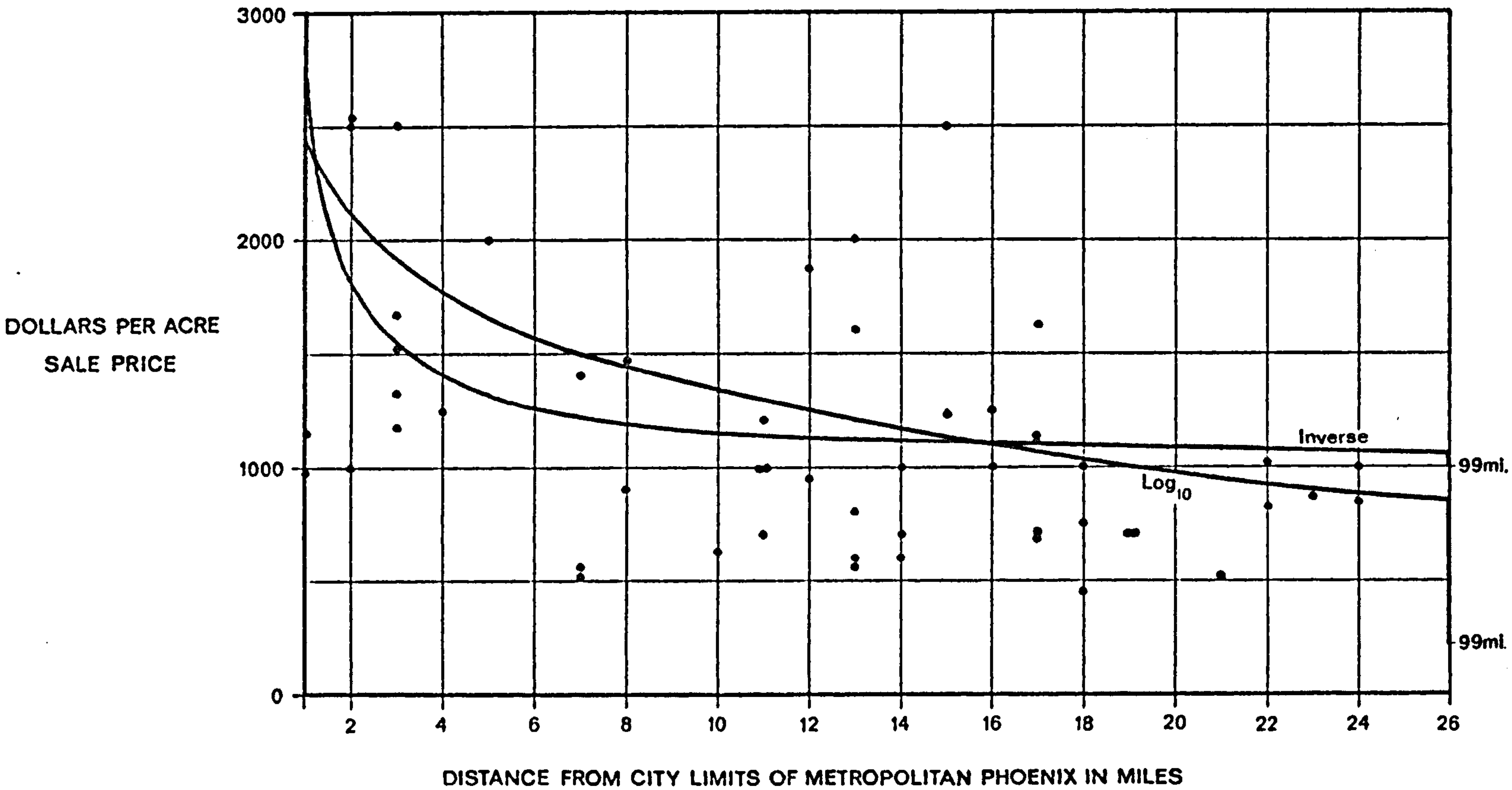

Figure 10. Regression Lines for Log Form and Simple Inverse Form of Distance Variable Against Empirical Sale Values

to the data beyond fifteen miles. Using the coefficients from these two models, the dependent variable (the sale price) was adjusted to remove the effect due to location and speculative influence.

From an empirical standpoint, this adjustment has the effect of adjusting the farm values to a location an infinite distance from Phoenix. In fact, the adjustment of per-acre values beyond fifteen miles is not very large, as would be expected in light of the nature of the reciprocal function.

These adjusted values of the dependent variable were run in a model which had no independent variable for distance. The results were not satisfactory, and this approach was abandoned. The distance variable was retained in its original form in subsequent models.

This work with the distance variable did reveal that some of the parcels located in close proximity to metropolitan Phoenix were being sold at prices far higher than any conceivable value for agricultural purposes. Per-acre prices for these sales remained very high even after the previously described adjustment procedure was performed. It was concluded that the speculative effects so completely dominated the value of land located very near Phoenix that the value of allotment acreage could probably not be identified. Therefore, all observations located less than 2.5 miles from metropolitan Phoenix city limits were deleted from the data, leaving 51 individual sales in Maricopa County over the period 1961-1967. These 51 sales constituted the data with which the remainder of the analysis was performed. These data are summarized in Table 11 of the Appendix.

Analysis Using Series I Models

Using $/acre as the dependent variable, the regression models in Table 3 were estimated. With this form of the model, the regression coefficients associated with the allotment variables represent changes in per-acre values as the proportion of the farm covered by allotment is increased by one per cent. Thus, to determine the value of an acre of allotment, it is necessary to multiply the regression coefficient by a factor of one hundred. Figure 11 illustrates the principle involved. With zero per cent of a farm having allotment, the intercept of the vertical axis gives the value of land without any allotment. The regression coefficient gives the slope of the line and provides the basis for projecting the line to one hundred per cent of the farm having allotment. The change in price in passing from zero to one hundred per cent represents the estimate of the value of an acre of allotment.

The SRP variable has an effect on land values that is significant at the five per cent level. Its regression coefficient can be interpreted as the average added

Table 3. Regression for Series I Approach Using Per-Acre Sale Price as the Dependent Variable

Model 1.

	Y_1 =	a +	D +	SS_{61} +	SS_{62} +	SS_{63} +	SS_{64} +	SRP
coefficients		589	-9.12	13.26	8.38	14.69	7.81	455
t-values			(2.33)**	(1.51)	(2.17)**	(3.90)**	(2.30)**	(3.85)**

R^2 = .589

D.F. residual = 44

Model 2.

	Y_1 =	a +	SS_{61} +	SS_{62} +	SS_{63} +	SS_{64} +	SS_{65} +	SS_{66} +	SS_{67} +	SRP
coefficients		378	13.86	15.79	21.51	12.88	11.44	10.33	9.24	558
t-values			(1.33)	(2.73)**	(3.54)**	(2.58)**	(1.59)	(.74)	(1.16)	(4.76)**

R^2 = .565

D.F. residual = 42

**Significant at 5% level.

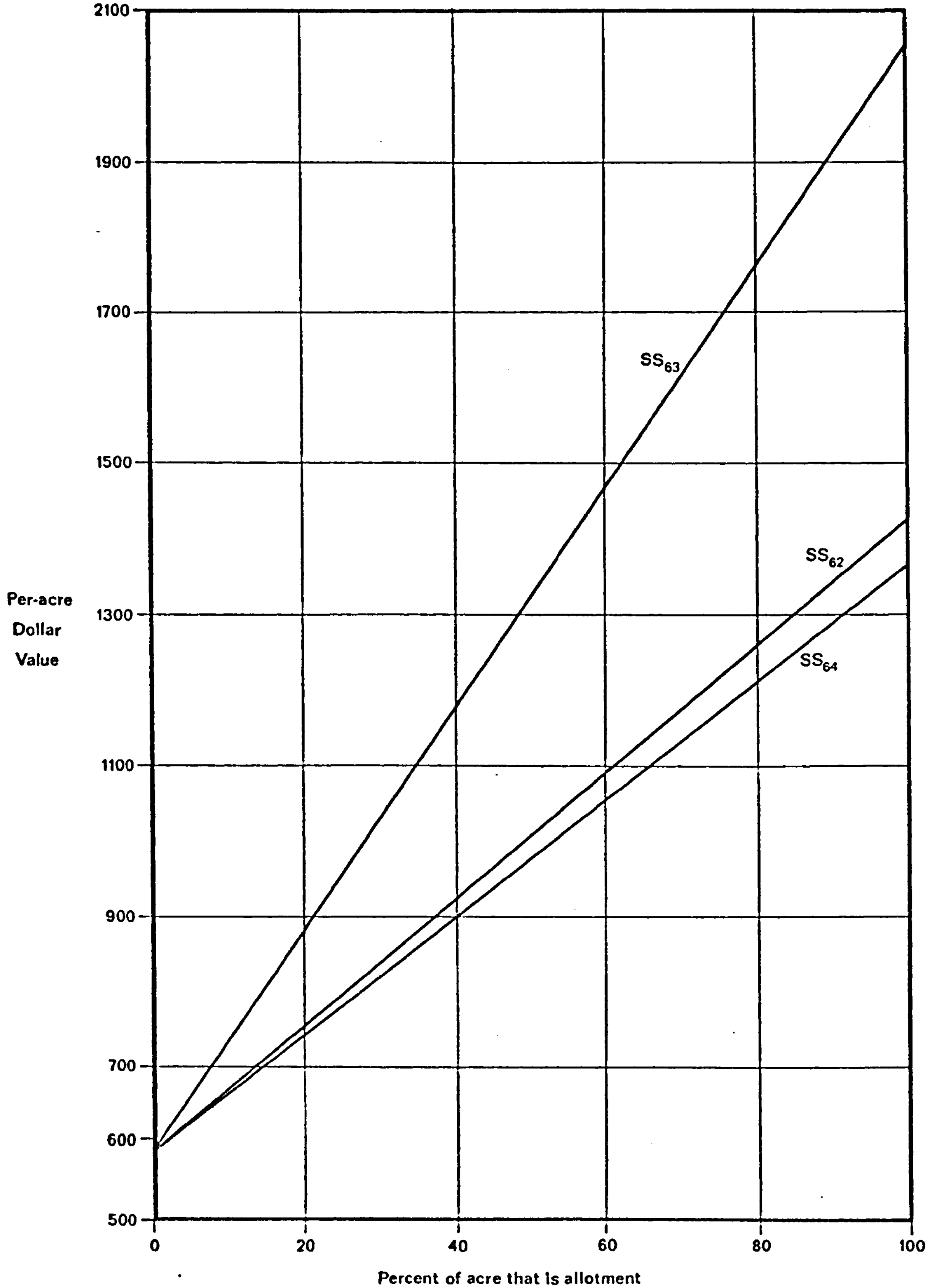

Figure 11. Extrapolation of SS Coefficients for Model 1 of Series I -- Source: Table 3.

value/acre occurring because a particular farm is located in a good water district rather than outside of it.

The relatively higher value ($558/acre) for the variable in Model 2 can be explained by the strong negative correlation between the distance variable and the SRP variable. The exclusion of the distance variable in Model 2 has the effect of inflating the SRP variable, in that the SRP variable is performing in part as a proxy for the distance variable.

The constant term reflects the average value of the dependent variable that is not explained by the independent variables in the models.

The only statistically significant regression coefficients on the allotment variables in these models are the 1962, 1963, and 1964 allotment coefficients.

According to these estimates, farm property in the Salt River Project, or a comparable water district, commands a substantially greater per-acre price than does comparable rural property outside of the Salt River Project water district.

The coefficient associated with the distance variable in Model 1 indicates that for every additional mile removed from the city limits of metropolitan Phoenix the average per-acre value of a parcel of land is expected to decrease by approximately $9.

Average annual allotment value estimates obtained by the procedure discussed earlier for interpreting allotment variable coefficients are summarized in Table 4.

Table 4. Per-Acre Allotment Value Estimates for Years 1961-1967

Model Year	Series I		Series II	
	#1	#2	#1	#2
1961	$1,326	$1,386	$1,000	$ 960
1962	838**	1,579**	1,205	1,190
1963	1,469**	2,151**	1,220	1,220
1964	781**	1,288**	1,105	1,110
1965		1,144	920	950
1966		1,033	735	745
1967		924	545	550
	R^2 = .589	R^2 = .565	R^2 = .949	R^2 = .940

**Significant at the 5% level.

Analysis Using Series II Models

Using total sale price as the dependent variable, the regression models in Table 5 were estimated. The coefficients for allotment acreage and net crop acreage variables were expressed as the actual number of allotment acres and net crop acres contained in each parcel.

Table 5. Regression Models Using Total Sale Price as the Dependent Variable (Series II)

Model 1.

$Y_2 = a + D + NC_{61} + SS_{62} + SS_{63} + NC_{64} + SS_{65} + NC_{65} + SS_{66} + NC_{67} + Pos + SRP$

	a	D	NC_{61}	SS_{62}	SS_{63}	NC_{64}	SS_{65}	NC_{65}	SS_{66}	NC_{67}	Pos	SRP
coefficients	(24,993)	(-796)	(1677)	(2722)	(2587)	(1202)	(-5120)	(3539)	((1770)	(941)	(25,763)	(22,749)
t-values		(1.97)*	(2.27)**	(12.54)**	(6.21)**	(5.45)**	(-2.55)**	(3.64)**	(2.20)**	(5.14)**	(1.86)*	(1.46)

$R^2 = .949$

D.F. residual = 39

Model 2.

$Y_2 = a + D + NC_{61} + SS_{62} + SS_{63} + NC_{64} + NC_{65} + SS_{66} + NC_{67} + Pos + SRP$

	a	D	NC_{61}	SS_{62}	SS_{63}	NC_{64}	NC_{65}	SS_{66}	NC_{67}	Pos	SRP
coefficients	(27,998)	(-933)	(1680)	(2710)	(2587)	(1190)	(1067)	(1746)	(928)	(27,074)	(20,458)
t-values		(2.19)**	(21.3)**	(11.71)**	(5.81)**	(5.06)**	(11.69)**	(2.04)**	(4.75)**	(1.83)*	(1.23)

$R^2 = .940$

D.F. residual = 40

*Significant at 10% level.

**Significant at 5% level.

The estimated coefficients for allotment acreage variables in this series of models represent the combined value of an acre of cropland and the value of an acre of allotment that was associated with that acre of cropland. To remove the segment of the value that is contributed by the cropland, it is necessary to subtract the appropriate net cropland coefficient from the allotment value coefficient. This procedure yields the residual value that can be attributed to the allotment.

Because the models do not yield meaningful coefficients for all of the allotment and net cropland variables, it is necessary to extrapolate in order to obtain values for each of the coefficients. This can be done by plotting the meaningful coefficient values for each set of variables against time, and connecting the points with straight lines. The vertical distance between the lines at a given year can be interpreted as the per-acre value of allotments for that year.

Table 4 presents annual per-acre allotment value estimates obtained by applying this procedure to coefficients derived from Models 1 and 2. The graphs for each of the models are shown in Figure 12. The results for Model 1 ignore the unexplainable coefficients for the 1965 allotment variable and the 1965 cropland variable.

Model 2 differs from Model 1 only in that the 1965 allotment variable is omitted in Model 2. When the shapes

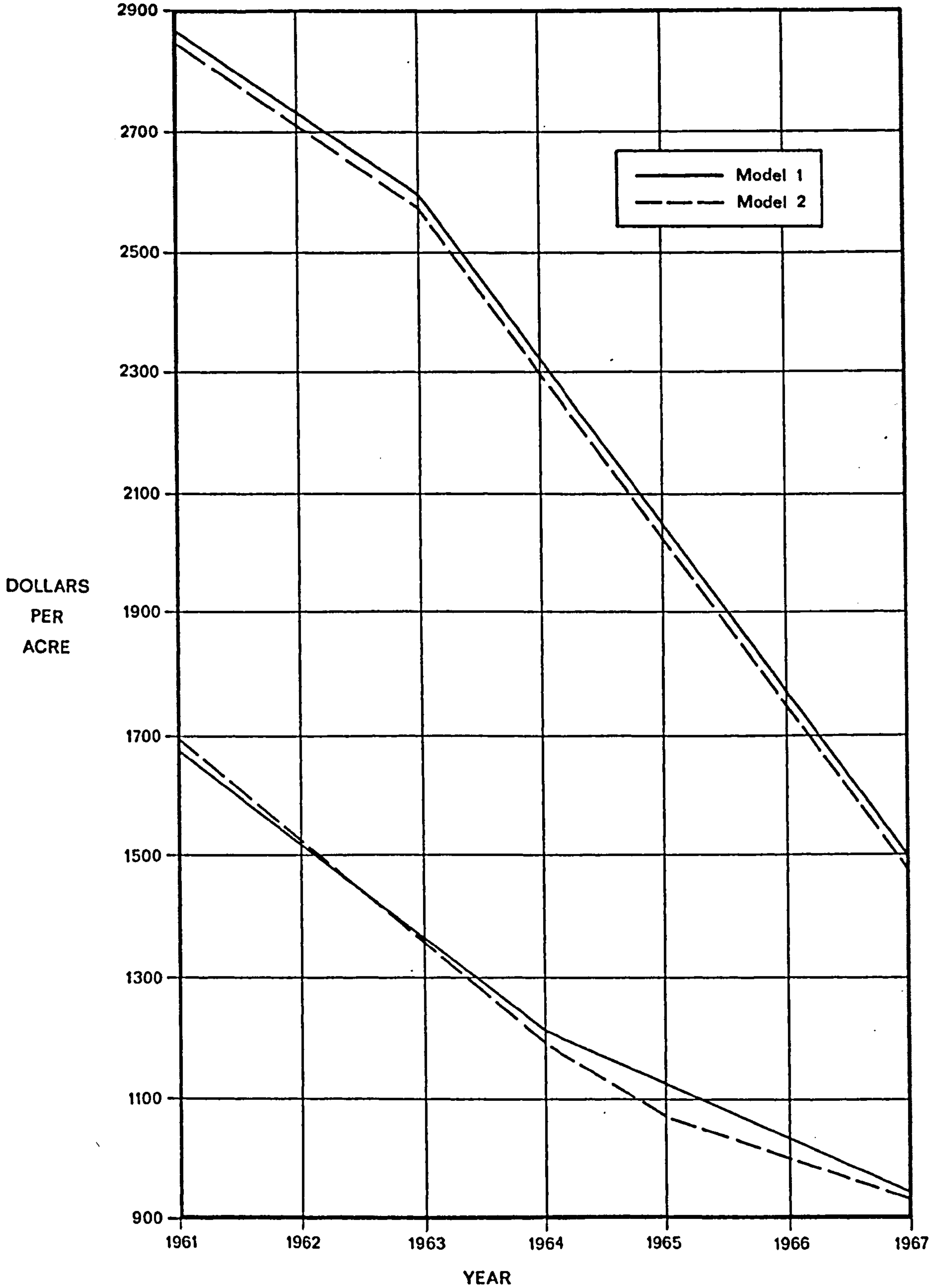

Figure 12. Simple Linear Relationship Between Allotment Acre Value and NC Acre Value -- Source: Table 5.

of net cropland graphs are compared for both models, the Model 2 graph suggests a curvilinear trend in net crop acre values.

The coefficient of multiple determination (R^2) is reasonably close to 1.00 for both models. This indicates that a major part of the variability in the dependent variable is explained by variability in the independent variables.

The sizeable constant term in both models signifies that a substantial amount of a farm's total value is not accounted for by the independent variables explicitly included in these models.

The coefficient for the distance variable is significant at the five per cent level in Model 2. The interpretation is that for each additional mile that the average farm is removed from the city limits of metropolitan Phoenix the total sale value will drop $933 on the average.

The coefficient for the "positive improvement" variable in Model 1 is significant at the ten per cent level. The magnitude of the coefficient associated with the "positive improvement" variable in each of the models is substantial, indicating that this variable makes a large contribution to the total sale price of farms having this characteristic.

The coefficient for the SRP variable in each of the models, although not significant at the ten per cent level, is substantial in magnitude. This suggests that the possession of SRP water rights may contribute heavily to the total sale value of a farm.

Evaluation of Results of Regression Analysis

The results obtained from the Series I models should not be regarded too heavily. Both Model 1 and Model 2 of this series have a low coefficient of multiple determination (R^2) value. Very few of the independent variables in these models have statistically significant coefficients associated with them.

The Series I estimates probably over-state the value of an acre of cotton allotment, particularly in the earlier years. This occurs because the estimating procedure allows only one value for net crop acres for all years, while this value seems to have declined during the period. For an early year in the series, the intercept is forced through a lower value than would be the case if free to find its own level and this causes the regression line on proportion of allotment to be steeper than it would be if each year's data were fitted independently.

Regressions were attempted with models including net crop variables, but the lack of independence between allotment acreage and net crop acreage variables gave unsatisfactory results. The models do indicate a peak allotment value for the year 1963 and continuously declining values thereafter. These findings are consistent with the results of the Series II models.

The allotment variable estimates obtained with the Series II regression models are more dependable from a statistical standpoint. Both models in this series meet the criteria for high R^2 values, indicating that the models "explain" a large proportion of the variability of the dependent variable. Many of the coefficients on the independent variables are significantly different from zero, as confirmed by the "t" test. Problems of inter-correlation among the independent variables representing net crop acreage and allotment acreage for the same year prevented the development of a regression model with all of these variables in it. The exclusion of some of the allotment and net crop acreage variables does not exclude the influence on the dependent variable associated with these omitted variables because of their high correlation. The influence of these deleted variables would be to over-state the value of the net crop acres and understate the value of the allotment variables. Because the estimate of pure allotment value depends upon subtracting the estimate of net crop value from allotment value, the net effect should be to understate the value of pure allotment.

Comparison of Allotment Income Flows and Allotment Values

Per-acre income above variable costs was calculated for active cotton allotment acres in Maricopa County during each year of the period 1961-1967. These trends in income levels were then compared with allotment value trends. Per-acre variable cost figures for a representative 320-acre Maricopa crop farm were obtained from an unpublished Master's thesis.[6]

Average gross income-per-acre figures were derived by dividing the number of "active" allotment acres in Maricopa County in a given year into the cash receipts (value of lint plus payments) for cotton for the same year.

"Active" allotment acreage is essentially planted acreage in 1961, 1962, and 1963. For 1964 and 1965, it is planted acreage plus diverted acreage under the voluntary program. In 1966 and 1967 the definition is acres participating in the program, including planted acres and acres diverted under the program. These statistics are summarized in Table 6.

The average income above variable costs is found by subtracting the variable cost figure from the per-acre average income figure. The income above variable cost

6. Richard C. Shane, "Risk and Diversification in Arizona Crop Farm Production," unpublished Master's Thesis, The University of Arizona, Tucson, Arizona, 1971, p. 74.

Table 6. Per-Acre Income Above Variable Costs for Maricopa County Cotton Allotments, 1961-1967

	Acres Planted[a]	Value of Production[b]	Payments[c]	Gross Income Per Acre	Variable[e] Costs Per Acre	Income Above Variable Costs
1961	137,670	$48,594,975		$353	$215	$138
1962	135,200	52,932,035		391	221	170
1963	121,900	44,821,600		368	220	148
1964	121,400[d]	36,414,000	$123,586	301	218	83
1965	121,777[d]	38,364,040	668,883	321	223	98
1966	122,917[d]	17,612,925	13,814,606	256	221	35
1967	124,436[d]	21,949,175	21,476,445	349	217	132

a. Arizona Crop and Livestock Reporting Service, Arizona Agricultural Statistics, 1970, Bulletin S-5, Phoenix, Arizona, March, 1970, p. 14.

b. Ibid.

c. Agricultural Stabilization and Conservation Service, Arizona Annual Report, Phoenix, Arizona, 1964, p. 32; 1965, p. 34; 1966, p. 27; 1967, pp. 27-28.

d. Includes diverted acreage eligible for payments. Source: Ibid.

e. Richard C. Shane, "Risk and Diversification in Arizona Crop Farm Production," unpublished Master's Thesis, The University of Arizona, 1971, p. 74.

figures are graphed in Figure 13 along with the allotment value trends.

With the exception of a minor uptrend in income in 1965, the per-acre income above the variable costs peaked in 1962, fell steadily through 1966, and finally jumped sharply in 1967 because of a sharp rise in the price of cotton.

Allotment value trends seem to generally lag one year behind the income trends. Allotment values peaked in 1963, and then fell sharply through 1967.

The 1965 upswing in income did not stem from the falling allotment value trend for 1966. The uncertainty surrounding the 1965 cotton program which became effective in 1966, may be the reason why allotment values did not respond to the improved income picture for 1965. It is also possible that the response was obscured in the regression analysis because of the data limitations.

This comparison indicates that allotment values are closely linked to income levels. Income at the producer level in turn is strongly influenced by government programs. This would imply that changes in allotment valuation are closely linked with cotton program modifications which affect per-acre income flows.

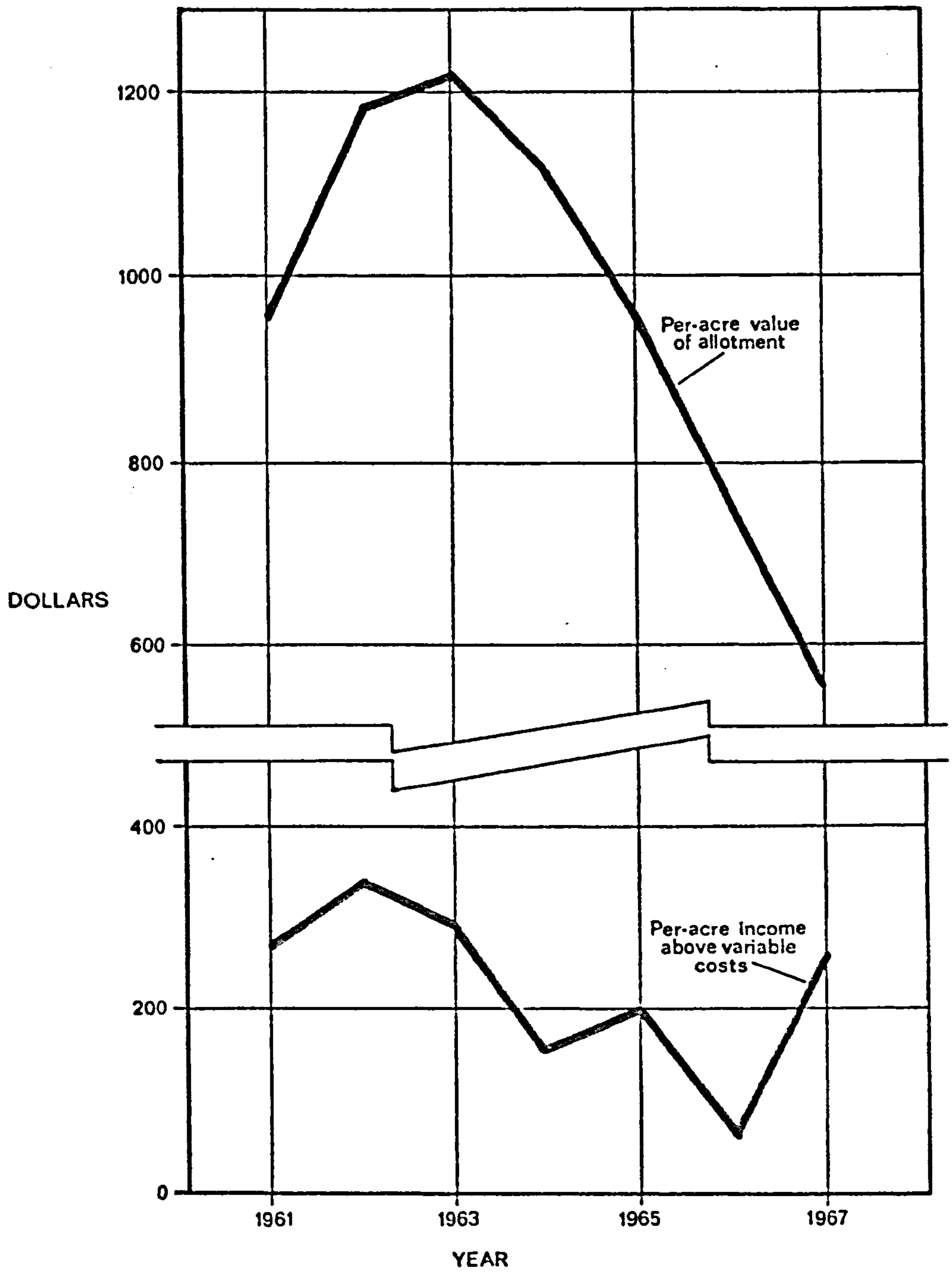

Figure 13. Comparison of Per-Acre Allotment Values with Income Above Variable Costs by Year -- Sources: Table 6 and Table 4.

CHAPTER V

AN INVESTIGATION OF YIELD AND OWNERSHIP PATTERNS FOR ARIZONA UPLAND COTTON ALLOTMENTS

If no reorganization of upland allotments took place, payment limitations would substantially reduce aggregate income to Arizona cotton producers.[7] Based on the results of the study presented in the previous chapter, allotment values would be expected to decline from their present levels because of the reduced income.

The payment limitation in the Agriculture Act of 1970, however, does not preclude a variety of potential reorganization schemes for allotments. By using various legal methods, producers can reorganize their allotment holdings for the purpose of avoiding the loss of payments on allotment acreage that was eligible to receive payments prior to the limitation legislation.

The nature of any farm reorganization, and the ease with which it could be accomplished, would depend heavily upon current allotment ownership and lease patterns for

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7. Robert S. Firch and Jeffery J. Weber, "Upland Cotton Allotments in Arizona and Potential Effects of Government Payment Limitations Based Upon 1970 Allotments," Agricultural Economics Department, The University of Arizona, Tucson, Arizona, October 10, 1970, Table 4.

Arizona cotton farms. An analysis of allotment ownership and lease patterns may serve to offer some insight into the nature and direction of potential allotment reorganization.

Because payments under the Agriculture Act of 1970 will continue to be based upon projected yield, the per-acre income will be affected importantly by changes in projected yield. The question arises as to whether re-organization of allotment acreage into smaller farming units, in order to avoid the payment limitation of $55,000, will have important effects on projected yields and, thus, on income and allotment values.

Source and Preparation of Data

This study is an analysis of allotment ownership and yield patterns on cotton farms in Cochise, Maricopa, Pima (including the one allotment planted in Santa Cruz County), Pinal, and Yuma Counties for the 1970 crop year. These five counties contain well over ninety-five per cent of Arizona's domestic allotment acreage, and account for an even larger proportion of the state's production by virtue of their relatively high per-acre yield levels.[8]

Information for this study was taken from individual farm record cards in each of the five county Agricultural Stabilization and Conservation Service Offices. The cards

8. Arizona Crop and Livestock Reporting Service, Arizona Agricultural Statistics, Bulletin S-5, Phoenix, Arizona, 1970, pp. 14-17.

contained names and addresses of operators, as well as a list of all owners of land recorded on that card.

For a given farm, the upland allotment acreage owned by the operator was clearly defined, as well as allotment acreage leased from the state and from the Indians. If an allotment lessor had the same surname as the operator, that portion of the tract was arbitrarily classified as "family lease." The residual acreage, remaining after the subtraction of allotment acres identified as owner-operated, leased from Indians, leased from state, and leased from family was classified as "leased from others." It should be noted that the definition of "family lease" does not include those cases where allotment was leased from relatives with different surnames. This tends to understate the "family lease" variable and to overstate the "leased from others" category.

The farm record card also provided a projected yield figure (hereafter called yield) for that tract which represents a moving three-year average of the actual yield for the tract.

In cases where it could be confirmed that the same operator was farming allotments listed on more than one farm record card, the information on the cards was combined and treated as a single farm. A weighted projected yield figure was calculated in these instances.

It was not possible to identify cases where a single operator farmed allotments in more than one county. In such cases, the farms were recorded as independent farming operations.

In this manner, data from 1,370 individual farming operations in the five counties was recorded on IBM cards. The 1970 payment for each farm was calculated using the 1970 payment level of 16.8 cents/pound of projected yield on the domestic allotment acreage. The following formula was used:

(Total Allotment Acres) x
(Projected Yield) x
($.168) x (.65) = Payment.

Analytical Procedure and Results

Variables of interest in this study are the following:

OO	Owner-operated allotment acres
LF	Allotment acreage classified as leased from family members
LO	Allotment acreage leased from private owners other than family, or leased from others
LS	Allotment acreage leased from the State of Arizona
LI	Allotment acreage leased from Indians
Y	Projected yield in pounds.

Payment per farm was used solely as a classification variable. All acreage figures for the ownership and leasing variables were expressed as proportions of the total acreage in a given farm.

The first objective of this study was to determine if the average yield varied significantly with changes in the ownership composition of a farm's allotment acreage. The independent variables were expressed as proportions of a given farm's allotment acreage. In other words, what is the contribution of an added acre of allotment, be it leased or bought, to the average yield of a farm?

Stepwise multiple-linear-regression analysis was the technique used for investigating this question. By regressing the ownership variables on the projected yield variable, coefficients could be obtained for the ownership and lease variables which would indicate the magnitude and arithmetic sign of a given variable's contribution to average yield.

Because the sum of the explanatory variables for a particular observation add to one, it is impossible to include all variables in the regression analysis at the same time.

The owner-operated variable was omitted in the equation because of the high proportion of owner-operated allotment acreage. By doing this, it was hoped that any remaining yield variability would be identified with the appropriate lease classification variable.

The general regression equations was the following:

$$\text{Yield} = a + b(LF) + c(LO) + d(LS) + f(LI).$$

Cochise County had no LI allotment; therefore, the LI variable was omitted from the model for that county. The constant and the mean of the dependent variable can be directly interpreted as average per-acre yield in pounds. The coefficients on the independent variables can be interpreted as deviations from the average yield of owner-operated allotments expressed in the constant. For example, if the regression constant has a value of 1,000 and the regression coefficient on the LS variable has a value of -200, this would indicate that the average acre of owner-operated allotment in that category had a projected yield of 1,000 pounds, while an acre of allotment on land leased from the state had a yield of 800 pounds.

Coefficients were evaluated for significance with the "t" test. No attempt was made to run regression models beyond a point where additional variables would be added at very low levels of significance.

Models were run for each county except Pima County, and a composite model was also run using only Maricopa and Pinal County observations (928 of the 1,370 farms). Pima County was not analyzed in this way because of the relatively small number of observations (farms) in the county and the unusually high proportion of LS allotment operated by many of the producers in the county.

The results of the study are summarized in Table 7. Blank spots in the tables are cases where variables did not enter the model before the regression was terminated.

Each of the models has a very low R^2 value, which indicates that the independent variables offer little explanation of the variability in the dependent variable. The constant values closely approximate the mean of the dependent variable. Yield on the owner-operated allotment acreage is probably the primary factor involved in determining the county average yield.

In looking at the coefficients for the independent variables, Indian lease allotment has a definite negative effect on projected yield in Maricopa and Pinal Counties. The LF and LS variables have a positive effect on average yield in Cochise County. Yuma County is characterized by very high yield levels and intensive farming, which may explain the strong positive effect of the LO variable on the projected yield levels for farms in that county.

In the second phase of this analysis, interest was focused on the variability of yield and allotment ownership characteristics between various farm-size groups. Specifically, the study sought to test the hypothesis that the average yield and the average proportions of allotment

Table 7. Multiple Regression Analysis Equations for Yield as a Function of Allotment Ownership Characteristics (to test if average yield varies with allotment composition)

County	R^2	Av. County Yield	=	a (constant)	+	b(LF)	+ c(LO)	+ d(LS)	+ f(LI)
Cochise	.030	780		765		304 (1.62)	--	302 (1.80)	--
Maricopa	.030	1008		1033		--	-51 (2.20)	--	-262 (3.99)
Pinal	.013	1132		1136		--	--	--	-201 (2.09)
Yuma	.042	1431		1375		--	181 (3.10)	--	--
Maricopa & Pinal	.029	1051		1077		--	-62 (3.11)	--	-257 (4.60)

t-value of coefficient in parentheses. t-value for ten per cent level of significance = 1.645; five per cent level of significance = 1.96.

acreage owned or leased from various sources significantly varied between farm-size groups.

The same data that was used for the regression analysis was utilized for this phase of the study. Payment level was the criteria for classifying farms into size groups. The potential payment level figures of $55,000 and $20,000 per farm were logical levels for dividing farms into groups because of the congressional debate about these levels of payment limitation. Group 1 included all farms receiving 0-$20,000 direct payments in 1970. Group 2 consisted of farms receiving $20,000-$55,000 payments, and Group 3 included farms receiving more than $55,000.

One-way analysis of variance was the statistical technique chosen for comparing the group means of each set of variables. The Student-Newman-Kuhl statistic[9] was the test applied to determine the significance of the difference between the group means. For the S-N-K test, group means are ranked in order and the two extreme means initially tested. If the difference between the two extreme means is significant, further tests can be made comparing means which are closer together in the rankings. This permits the researcher to better identify any significant variation among a series of group means. The S-N-K test adjusts for

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9. R. G. D. Steel and J. H. Torrie, Principles and Procedures of Statistics (New York: McGraw-Hill, 1960), p. 110.

the number of means being tested across, as well as for the number of observations in each of the two groups being compared. Test criteria were the one per cent level of significance and the five per cent level of significance.

Analysis of variance was run on each of the following variables: Y, OO, LF, LO, LS, and LI. This procedure was carried out for each of the five counties for which data were available, as well as for the entire five counties considered as a whole. The results are summarized in Tables 8 and 9.

In all cases, group means are ranked lowest to highest. The numbers in the parentheses behind the group number for yield represent the number of farms, or observations, in each group (treatment).

Results of Analysis of Variance

Looking first at the yield variable, the five-county composite indicates a significant difference in average yield between every possible combination of farm-size group at the one per cent level of significance. The ranking is an important point because it indicates a significantly larger yield as farm size increases. With the exception of Pima County, the ranking persisted in all counties. Pima County was the only county where no significant difference in yield existed between any of the

Table 8. ANOVA Results for Individual Counties

Variable	Treatment Rank	Treatment Mean	Significance
		Cochise	
Y	1(153)	725	1 vs. 3*
	2(21)	1114	1 vs. 2*
	3(2)	1455	2 vs. 3
OO/total	3	.245	3 vs. 1
	2	.418	--
	1	.618	--
LF/total	1	.021	1 vs. 3
	2	.029	--
	3	.120	--
LO/total	1	.342	1 vs. 3
	2	.477	--
	3	.635	--
LS/total	3	--	3 vs. 2
	1	.019	--
	2	.076	--
LI/total	No LI in Cochise County		
		Maricopa	
Y	1(396)	1032	1 vs. 3*
	2(143)	1123	1 vs. 2*
	3(64)	1221	2 vs. 3*
OO/total	2	.466	2 vs. 1**
	3	.536	--
	1	.566	--
LF/total	3	.046	3 vs. 1
	2	.068	--
	1	.069	--
LO/total	1	.338	1 vs. 2
	3	.366	--
	2	.429	--

Table 8.--Continued ANOVA Results for Individual Counties

Variable	Treatment Rank	Treatment Mean	Significance
LS/total	1	.006	1 vs. 3
	2	.006	--
	3	.013	--
LI/total	1	.021	1 vs. 3
	2	.023	--
	3	.046	--
		Pima	
Y	3(10)	907	3 vs. 2
	1(16)	955	--
	2(21)	980	--
OO/total	3	.358	3 vs. 1
	2	.608	--
	1	.636	--
LF/total	2	.024	2 vs. 1
	3	.068	--
	1	.125	--
LO/total	1	.239	1 vs. 3
	2	.310	--
	3	.376	--
LS/total	1	.000	1 vs. 3
	2	.059	--
	3	.198	--
LI/total	No LI allotment in Pima County		
		Pinal	
Y	1(102)	999	1 vs. 3*
	2(129)	1191	1 vs. 2*
	3(94)	1196	2 vs. 3
OO/total	2	.647	2 vs. 3
	1	.653	--
	3	.661	--

Table 8.--Continued ANOVA Results for Individual Counties

Variable	Treatment Rank	Treatment Mean	Significance
LF/total	3	.028	3 vs. 2
	1	.070	--
	2	.073	--
LO/total	2	.223	2 vs. 1
	3	.245	--
	1	.256	--
LS/total	1	.001	1 vs. 3**
	2	.033	--
	3	.050	--
LI/total	3	.015	3 vs. 2
	1	.020	--
	2	.023	--
		Yuma	
Y	1(134)	1354	1 vs. 3*
	2(53)	1489	1 vs. 2*
	3(32)	1657	2 vs. 3
OO/total	3	.358	3 vs. 1
	2	.495	--
	1	.541	--
LF/total	3	.009	3 vs. 2
	1	.026	--
	2	.045	--
LO/total	1	.274	1 vs. 3
	2	.327	--
	3	.426	--
LS/total	3	.016	3 vs. 2
	1	.020	--
	2	.036	--

Table 8.--Continued ANOVA Results for Individual Counties

Variable	Treatment Rank	Treatment Mean	Significance
LI/total	2	.097	2 vs. 3
	1	.140	--
	3	.192	--

*Indicates group means significantly different at the one per cent level of significance.

**Indicates group means significantly different at the five per cent level of significance, but not significantly different at the one per cent level of significance.

Table 9. ANOVA Results for 5-County Composite

Variable	Treatment Ranking	Treatment Means	Comparison of Means
Y	1(801)	971 lbs.	1 vs. 3*
	2(367)	1191	1 vs. 2*
	3(202)	1265	2 vs. 3*
OO/total	2	.539	2 vs. 1
	3	.554	--
	1	.584	--
LF/total	3	.034	3 vs. 2
	1	.054	--
	2	.062	--
LO/total	1	.315	1 vs. 2
	3	.322	--
	2	.338	--
LS/total	1	.010	1 vs. 3*
	2	.030	1 vs. 2*
	3	.037	2 vs. 3
LI/total	2	.031	2 vs. 3
	1	.037	--
	3	.052	--

*Indicates group means significantly different at the one per cent level of significance.

farm-size groups. This is probably a result of the smaller number of farms (47) spread rather evenly according to size.

It can be seen that no significant difference in average yield existed between Group 2 and Group 3 farms in Cochise, Yuma, and Pinal Counties at the one per cent level. This suggests that, on the average, no sacrifice in yield would be expected to accompany allotment transfers from Group 3 to Group 2 farms in these counties. Group 1 farms, however, had significantly lower yields than Group 2 or 3 farms in all counties except Pima. This indicates that, with the level of management and other things held constant, yield losses would be expected with the transfer of land from larger farms to farms currently receiving less than $20,000 in payments.

The only other variable exhibiting any significant difference at the one per cent level was the LS variable. The Group 1 farms had a significantly smaller proportion of LS allotment on the average than the Group 2 or Group 3 farms. The group ranking for this variable in each county bears this out, despite the absence of any significant difference between group means at the county level for the LS variable at the one per cent level. The LS variable was significant at the five per cent level in Pinal County.

The other variables exhibited no significant difference at the one per cent level between group means in any of the analyses. At the five per cent level of significance, the OO variable exhibited a significant difference between group means for the Group 1 and Group 2 farms. Looking at the group rankings, it can be seen that smaller farms generally have a higher proportion of owner-operated allotment, whereas larger farms have a larger proportion of leased allotment. This would suggest that larger farms, especially those which earned more than $55,000 in cotton payments in 1970, could adjust their allotment acreage more easily than smaller operations by simply not renewing their allotment leases. This generalization cannot be proven from a statistical standpoint, but is merely a suggestion based upon the observed patterns in allotment ownership.

Conclusion

The regression analysis indicates that allotment ownership patterns have no consistent and significant influence on yield levels. The analysis of variance went on to demonstrate that significant yield differences exist between farms receiving less than $20,000 in government payments and larger farms. The analysis of variance also showed that allotment ownership patterns did not vary significantly among farm-size groups. Factors other than the allotment ownership patterns seem to influence yield levels significantly as farm size increases.

Payment limitations will necessitate some reorganization of allotments to avoid payment loss. Allotment transfer will probably begin with the transfer of relatively mobile, leased allotment acreage. Regardless of what type of allotment is transferred, this study indicates a possible decline in average yield for transfers from larger operations to smaller operations. Transfer to farms currently receiving less than $20,000 in payments would mean, all else being equal, significant reductions in yield levels and reduced income for Arizona upland cotton growers.

CHAPTER VI

CONCLUSIONS

As a federally regulated crop, upland cotton has provided farmers with relatively stable income levels over the past twenty-five years. Throughout this period of time continuing gains in productivity, declining markets, and an inability to find some generally accepted means of distributing program benefits have caused the government to periodically revise upland cotton programs.

Arizona cotton producers, with some of the larger farms and the highest per-acre yields in the nation, are affected significantly by these changes. Substantial program modifications in 1965, and again in 1970, raise some serious questions concerning the future profitability of upland cotton and potential changes in allotment values.

Historical allotment sales data indicate a downward trend in Arizona allotment values following the 1965 program legislation. Furthermore, with the imposition of a $55,000 payment limitation, a substantial portion of the state's allotment acreage could be excluded from receiving subsidy payments, meaning loss of income and further declines in allotment valuation. The potential effects of a $55,000 limitation will be buffered by reorganization and transfer of allotment acreage for the purpose of preserving the eligibility of the allotments to receive payments.

In some cases, reorganization will be a mere legal manipulation, having no effect on the physical makeup of the farm. But with 202 of the 1,370 farms analyzed having potential payments in excess of the limit, it is doubtful that reorganization will be either complete or painless. Some of the current domestic allotment acreage may become ineligible for payments, which means a loss of income. Some allotments will be transferred, probably at reduced value, to smaller farms, which may well realize less per-acre income as a consequence of lower per-acre yield levels. This again means loss of income for the cotton producers.

It is difficult to speculate on future aggregate yield and income levels for Arizona without full knowledge of the factors which influence yield. This study, however, indicates that higher yields are associated with larger upland cotton farms.

Allotment value is closely linked to income. To the extent that program legislation and yield variability affect per-acre income, a corresponding change in the allotment value can be expected. The magnitude of the change will depend on how the individual producer chooses to discount the expected income flow. This study suggests that any movement toward smaller-scale cotton farming operations would be expected to result in reduced per-acre income levels and lowered per-acre allotment values.

The changes that a $55,000 limitation would necessitate are expected to have an adverse impact on income and allotment value in the state. A $20,000 limitation would probably cause substantial loss of payments in Arizona. The $20,000 limitation would affect 569 of the 1,370 farms studied, and well over one-half of the 1970 domestic allotment acreage in Arizona would be ineligible for payments at this lower level if the limitation were effectively enforced. There is no question that a transfer of allotment acreage to farms which earned less than $20,000 in payments in 1970 would mean significant reductions in yield levels.

APPENDIX

ADDITIONAL FARM SALES
INFORMATION

Table 10. Classification of Water Districts

Classification	District
Good	Salt River Project Arlington Canal Company
Fair	Roosevelt Irrigation District Buckeye Irrigation Company Buckeye Water Conservation and Drainage District
Poor	Roosevelt Water Conservation District Saint John's Irrigation District McMicken Irrigation District Maricopa County Municipal Water Conservation District Private Well

Table 11. Farm Sales Data Used for Allotment Value Regression Analysis

Sale #	Total Price	Dis-tance	Upland Allotment Acres	Net Crop Acres	Non-Crop Acres	Year Sold	Positive Improve-ments	Negative Improve-ments	Water Situa-tion
1	900,000	7	122	501	17	1961			SRP
2	48,000	63	22	38	20	1961			Well
3	25,000	99	26	46	128	1961			Well
4	448,000	22	145	282	13	1961			Well
5	53,000	3	15	23	2	1962			SRP
6	66,000	13	45	71	4	1962		1	Well
7	80,000	17	23	46	1	1962			RID
8	76,000	12	26	39	16	1962	1		Well
9	511,000	13	182	434	24	1962			Well
10	128,000	13	29	45	6	1962			Well
11	90,000	4	43	27	2	1962			SRP
12	36,300	7	9	55	1	1962	1		SRP
13	59,400	8	13	23	4	1962			SRP
14	350,000	3	54	78	8	1962	1		SRP
15	55,250	15	12	29	4	1963			SRP
16	100,000	15	16	22	2	1963	1		SRP
17	200,000	13	34	56	10	1963			SRP
18	40,000	40	9	41	0	1963			RID
19	72,000	11	15	41	4	1963		1	Well
20	40,000	16	13	24	3	1963			RID
21	23,500	17	10	17	7	1963			RID
22	65,000	17	19	19	2	1963	1		RID
23	112,500	18	50	96	4	1963			RID
24	160,000	24	61	98	1	1963	1		RID
25	145,000	32	53	197	30	1963			Well
26	77,500	11	23	54	1	1963			Well
27	208,000	5	45	57	2	1963	1		SRP
28	46,142	3	14	23	2	1963			SRP

Table 11.--Continued

Sale #	Total Price	Dis- tance	Upland Allotment Acres	Net Crop Acres	Non- Crop Acres	Year Sold	Positive Improve- ments	Negative Improve- ments	Water Situa- tion
29	10,000	14	7	2	1	1964		1	Well
30	148,000	18	48	100	2	1964		1	RID
31	190,755	22	84	148	4	1964	1		RID
32	130,980	23	50	87	11	1964	1		RID
33	112,459	24	46	80	7	1964	1		RID
34	126,000	3	22	52	1	1964		1	Well
35	50,000	16	18	21	1	1964			Well
36	75,000	12	20	18	2	1964			Well
37	144,000	8	49	111	0	1965			RID
38	28,000	11	12	28	0	1965			RID
39	140,000	14	67	133	0	1965			RID
40	224,000	17	105	215	0	1965	1		Well
41	448,000	19	210	430	0	1965			Well
42	334,260	3	62	160	0	1965			Well
43	86,050	18	44	68	73	1965	1		Well
44	167,500	17	50	99	1	1965			RID
45	102,000	13	51	65	54	1966			Well
46	35,000	7	6	39	22	1966			SRP
47	56,000	19	8	72	0	1966			RID
48	102,900	14	30	89	53	1967		1	Well
49	40,000	11	12	28	0	1967			RID
50	181,000	21	125	175	40	1967	1		Well
51	209,500	10	130	160	40	1967	1		Well
52[a]	140,000	2	16	39	1	1961			Well
53[a]	312,000	1	60	212	48	1963	1		SRP
54[a]	135,000	2	13.5	38	2	1964		1	SRP
55[a]	240,000	1	50	140	20	1965	1		SRP
56[a]	30,000	2	9.7	20	0	1966			SRP

[a]Sales which were omitted from final analysis because of nearness to metropolitan Phoenix city limits (i.e., less than 2.5 miles).

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