7-1982

Analysis of Optimum Cotton Marketing Structure in Tennessee

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July 1982
Bulletin 609

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FOREWORD

This is a contributed report to Southern Regional Research Project S-113 entitled, "Efficiency of Identification, Assembly, and Transportation of Cotton to Mills and Export Outlets."

TABLE OF CONTENTS

	Page
FOREWORD	3
TABLE OF CONTENTS	5
INTRODUCTION	7
OBJECTIVES	8
PROCEDURE	9
MODEL SPECIFICATION	10
Supply Areas and Gins	10
Farm-to-Gin Assembly Cost	12
Gin Processing Cost	12
Gin-to-Warehouse Transfer Cost	13
Warehouse Facilities	13
Warehouse to Outlet Transfer Cost	15
Outlet Demand	15
FINDINGS	15
No-Opportunity Cost Model	15
Opportunity Cost Model	19
IMPLICATIONS AND CONCLUSIONS	19
REFERENCES CITED	22
APPENDIX TABLES	24

ANALYSIS OF THE OPTIMUM COTTON MARKETING STRUCTURE IN TENNESSEE

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INTRODUCTION

During the past 15 years, cotton production in Tennessee has been quite unstable (Table 1). Harvested acreages increased from 236,000 acres in 1967 to 500,000 in 1974, but then declined for several years to 230,000 acres in 1978 and 1979 [12,14,15]. The cotton acreage for 1981 is reported at 305,000 acres [11]. Equally important to overall production, fluctuations in yield per acre ranged from 296 (1967) to 575 (1971) pounds. Projected yield for the 1981 crop is set at 496 pounds per acre [11]. Unlike the fluctuations in acreage and yield, there has been a steady decline in the number of active cotton gins. In 1966, there were 237 active gins in Tennessee. By 1980, the number had diminished to 90 [13 and 15]. This reduction in the number of gins is consistent with the pattern in other southern states.

Economic pressure for efficiency in the cotton subsector has focused attention on all stages of the cotton production-marketing system. The future of Tennessee's cotton industry may depend partially upon policy-type decisions of entrepreneurs regarding the movement and handling of cotton from farm to mill. While national organizations representing cotton growers may effectively deal with competition from synthetic fibers, other cotton industry participants must confront the escalating costs of marketing cotton. Hence, the long-run survival of Tennessee's cotton industry could depend upon decisions in the next few years regarding gin closures and/or replacements. Soybeans have replaced cotton on many Tennessee farms and the resulting cotton acreage reduction has forced the closing of many gins. Once gins cease operation, it is difficult for cotton production to return to the area because a local gin will no longer be readily available. The cost of a new gin would probably be prohibitive considering the volumes necessary to support such an expenditure [5 and 8].

Specific research on the economics of optimum cotton gin and warehouse organization in Tennessee is nonexistent; however, three studies have focused on this general problem in other cotton-producing regions. The least-cost organization of cotton ginning facilities in the San Joaquin Valley of California was examined by Moore and Courtney in 1971 [7]. The Oklahoma and Texas Plains gin-warehouse structure was examined by Cleveland in 1974 [1]. New Mexico's Rio Grande Valley cotton ginning in-

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dustry was examined by Fuller and Washburn in 1974 [2]. None of these three studies allowed seed cotton to move across county lines for ginning nor included an opportunity cost that might alter the analysis of an extended ginning season. Both of these situations were examined in the analysis of Tennessee's cotton marketing industry reported here.

Table 1. Cotton acreage harvested, production, and number of gins in Tennessee, 1966-1980.

Year	Acreage harvested	Production	Gins	
			Active	Idle
	1000 acres	1000 bales	number	
1980	275	194	90	30
1979	230	169	91	36
1978	230	228	102	42
1977	300	249	131	27
1976	370	223	145	33
1975	315	217	154	32
1974	510	303	175	17
1973	440	424	181	15
1972	485	523	196	12
1971	425	509	200	23
1970	390	386	205	25
1969	400	417	212	26
1968	360	322	229	20
1967	236	146	229	24
1966	365	363	237	24

Source: U.S. Bureau of Census [13,14,15].

OBJECTIVES

The general purpose of this study was to investigate the long-run planning problem of Tennessee's cotton industry regarding the optimal sizes and locations for gins and warehouses. Insight obtained from this normative analysis should assist policy makers to develop more efficient policies regarding industry organization, i.e., the optimum organization of cotton gins and warehouses in Tennessee. Potential investors should also benefit from information regarding the most feasible size and location for gin expansions and/or replacements.

The specific objectives of this study were:

1. To estimate the least-cost spatial flows for Tennessee cotton from farm to gin, gin to warehouse, and warehouse to domestic mill and export outlet.
2. To estimate the least-cost spatial organization and temporal structure for cotton gins and warehouses in Tennessee.
3. To evaluate the effect on optimum industry organization from the opportunity cost of an extended ginning season.
4. To determine the most efficient mode(s) for transporting cotton from warehouse to domestic mill and export outlet.

PROCEDURE

To accomplish the specified objectives, a cost minimization programming model was developed. An assumed goal of this type model is that the diverse objectives of society are reasonably represented in an objective function designed to minimize the combined cost of assembling, ginning, and transporting cotton. Hence, the programming model yields "optimal" solutions that vary with adjustments in the assumptions and/or specifications of the model.

The basic programming model was designed to consider each cotton-producing county within Tennessee as comprising a set of spatially separated seed cotton supply areas. Several of the larger cotton producing counties were divided into smaller units to coincide with potential gin sites. At least one potential gin site was designated in each county. The counties divided into smaller geographic supply areas had potential gin sites in each of these supply areas. Hence, one potential gin site was designated within each cotton supply area. The costs of assembling and ginning cotton were obtained from secondary sources [1,8].

Potential warehouse sites were selected to provide reasonable coverage of the supply area. Due to ample storage capacity of existing warehouse facilities in West Tennessee, each potential warehouse location was assumed to have unlimited capacity. This assumption properly permits the focus to be placed on the costs of shipping cotton. The final demand specifications for shipments from Tennessee warehouses to domestic mills and export outlets were assumed to be proportionally the same as estimated for the 1975-76 season in prior research [6].

A linear programming algorithm was modified to permit analysis of both the spatial equilibrium aspect of this problem and the non-linear gin processing cost functions [9]. Linear programming techniques are well suited for solving problems regarding the shipment of a homogenous product from a number of origins, through a number of intermediate points, to a number of destinations. A separable programming operating mode was used to incorporate the non-linear ginning cost functions into the base model. After a solution was obtained to the base model, an opportunity cost was added to evaluate the impact this expense would have on the feasibility of an extended ginning season (32 compared to 14 weeks).

The base year selected for this study was 1976. Industry parameters fluctuate from year to year, yet fundamental changes in the structure of the industry occur rather slowly over a longer period of time. Therefore, in selecting the base year, availability and quality of data were considered to be more important than merely the timeliness of some portions of the required data.

MODEL SPECIFICATIONS

A representative linear programming matrix is presented in Figure 1. Mathematically, the basic format of the cost minimizing model can be represented as follows: minimize

$$TC = \sum_{k=1}^{34} \sum_{i=1}^{34} (A_kC_i)(S_kG_i) + \sum_{i=1}^{34} f(QG_i)$$

$$+ \sum_{i=1}^{34} \sum_{j=1}^{11} (H_iC_j)(G_iW_j) + \sum_{j=1}^{11} \sum_{l=1}^{10} (D_jC_l)(W_j\phi_l)$$

where:

TC	=	total cost of assembling, ginning, and transporting cotton from gin to warehouse to final outlet
A_kC_i	=	assembly cost per bale for shipping cotton from supply area k to gin i, for $k = 1, \ldots, 34$ and $i = 1, \ldots, 34$
S_kG_i	=	bales of cotton shipped from supply area k to gin i, for $k = 1, \ldots, 34$ and $i = 1, \ldots, 34$
$f(QG_i)$	=	non-linear function for cost of ginning quantity Q in gin i
H_iC_j	=	transport cost per bale for shipping cotton from gin i to warehouse j, for $i = 1, \ldots, 34$ and $j = 1, \ldots, 11$
G_iW_j	=	bales of cotton shipped from gin i to warehouse j, for $i = 1, \ldots, 11$ and $j = 1, \ldots, 10$
D_jC_l	=	transport cost per bale for shipping cotton from warehouse j to domestic mill or export outlet 1, for $j = 1, \ldots, 11$ and $1 = 1, \ldots, 10$
$W_j\phi_l$	=	bales of cotton shipped from warehouse j to domestic mill or export outlet l, for $j = 1, \ldots, 11$ and $l = 1, \ldots, 10$

Supply Areas and Gins

Counties producing less than 500 bales of cotton in 1976 were excluded from this study. The remaining counties were subdivided into supply areas so that the total number of county subdivisions was equal to the number of potential gin sites (Appendix Table 1). Geographical delineation of these subdivisions' supply areas would have been preferred, but was not possible

			Transporting cotton from 2 supply areas (S) to 2 gins (G)				Transporting bale cotton from 2 gins (G) to 2 warehouses (W)				Transporting bale cotton from 2 warehouses (W) to 2 final destinations (ϕ) by rail (R) and truck (T)								Cost of ginning cotton, 2 gins (G) and 2 processing costs (P)				
			S1G1	S1G2	S2G1	S2G2	G1W1	G1W2	G2W1	G2W2	W1ϕ1R	W1ϕ1T	W1ϕ2R	W1ϕ2T	W2ϕ1R	W2ϕ1T	W2ϕ2R	W2ϕ2T	G1P1	G1P2	G2P1	G2P2	RHS
Supply area constraints	S1	L	1	1																			S
	S2				1	1																	S
Gin processing costs	GP1	G	–1		–1														P	P			O
	GP2	G		–1		–1															P	P	O
Transfer cotton from gin to warehouse	G1	G	1		1		–1	–1															O
	G2	G		1		1			–1	–1													O
Transfer cotton from warehouse to final demand point	W1	G					1		1		–1	–1	–1	–1									O
	W2	G						1		1					–1	–1	–1	–1					O
Final demand point accounting rows	ϕ1R	G									1				1								O
	ϕ1T	G										1				1							O
	ϕ2R	G											1				1						O
	ϕ2T	G												1				1					O
Demand point requirements	Dϕ1	G									1	1			1	1							D
	Dϕ2	G											1	1			1	1					D
Warehouse capacities	W1C	L					1		1														W
	W2C	L						1		1													W
Objective function	ϕbj	N	C	C	C	C	C C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	•

Figure 1. Programming matrix illustrating the model with 2 supply areas, 2 gins, 2 warehouses, 2 demand areas, and 2 processing segments for each gin.

due to inadequate production data. Confronted with this limitation, it was assumed that within a particular county each supply area contributed equally to that county's cotton production. Potential gin locations were selected by the author with the intent of conforming to the existing gin location pattern. However, only one gin site was designated within each supply area.

Farm-to-Gin Assembly Cost

An assembly cost function was developed from secondary farm-to-gin cost data [1]. While modular cotton may alter the assembly cost in some states, all cotton in Tennessee is ginned from trailers [5]. The functional relationship used in this study to account for assembly cost was a simple linear relationship based on mileage between the farm and the gin.[1]

$$AC_{ki} = 8.844 + 0.0141M_{ki}$$

where

AC_{ki} = assembly cost per bale, in dollars, for transporting cotton from supply area k to gin i

8.844 = fixed cost (or intercept) associated with transporting cotton from farm to gin

0.0141 = variable cost (or slope) associated with transporting cotton from farm to gin

M_{ki} = estimated mileage between supply area k and gin i

Estimation of assembly mileage within a given supply area was considered infeasible; hence, all intra-supply area shipments were specified to have an assembly cost of $8.844 per bale. Estimation of inter-supply area shipments required the point of origin to have the same polar coordinates as the potential gin location. The mileages between supply areas and gins were calculated by a model matrix generator with an imbedded polar coordinate subroutine.[2] While the shipments of seed cotton were permitted to cross county boundaries to reach potential gin locations, the maximum distance allowed in the model for seed cotton shipments was 25 miles.

Gin Processing Cost

Ginning costs incorporated into the transshipment model designed in this study to examine the farm-to-mill cotton transfers were based on previous research [7 & 8]. An implicit objective of this study was to analyze the im-

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[1]This functional relationship was developed by adjusting and updating information first reported by O. A. Cleveland, Jr. [1].

[2]The reader interested in a detailed discussion of this mileage estimating procedure is referred to French [3], Stennis [10], and Tramel [12].

pact on cotton ginning economies of size and scale as the result of increased assembly cost incurred by enlarging the area served. Annual capacity of a given gin operation can be expanded by lengthening the processing season. In this study, the normal 14-week ginning season and an extended 32-week season were evaluated.

The processing cost functions were initially developed for 7, 14, 21, 28, and 35 bale-per-hour facilities [1]. For use in the programming model, these nonlinear processing cost functions were divided into seven linear segments. With each nonlinear cost function represented by seven linear segments, the model would have required 70 activities for each potential gin site (5 sizes x 2 seasons x 7 segments). This large number of activities expanded the model beyond reasonable limits, considering benefits and costs. In order to reduce the number of activities in this phase of the model, a synthesized processing cost function was developed for each of the ginning seasons. For a given volume of cotton, for both the 14 and 32 week seasons, there may be more than one size gin that can process the cotton, but only one particular size will minimize cost. These minimum cost points were united to form an inclusive, envelope-type processing function for all gins. This procedure was followed independently in developing the 14- and 32-week season functions. Next, the two curves were combined to form one processing cost function that would identify the least cost gin size for a given volume.

Prior research in this area did not include an expense to account for the opportunity cost associated with the longer ginning season. The major consideration was the income that producers could have obtained on their capital if the cotton had been ginned and marketed in 14 weeks instead of 32. In an effort to evaluate the impact of this opportunity cost, a charge of 10 percent per annum was assessed over the 18 weeks the cotton was delayed from entering the marketplace because of the extended ginning season. The cost estimates for the no-opportunity and opportunity cost functions are presented in Table 2.

Gin to Warehouse Transfer Cost

The transfer of cotton from gin to warehouse was assumed to move by truck. This was not an unrealistic assumption because prior research revealed that only a small quantity of cotton is shipped by rail from a gin to a warehouse [6]. As expected, transfer cost was directly related to length of shipment, but not in a smooth, continuous function. The estimated costs began at $0.72 per bale for cotton shipped 10 miles or less and increased in discrete increments to $1.98 for shipments over 150 miles (Table 3).

Warehouse Facilities

Potential warehouse sites within the Tennessee cotton-producing region were identified with concern for existing warehouse locations as well as new locations that seemed to be intuitively suitable. All of the potential

Table 2. Gin processing cost estimates for both the no-opportunity cost and opportunity cost model, Tennessee, 1976.

Seasonal volume	Total cost	Average cost	Marginal cost
	No-Opportunity Cost Model		
	---dollars---		
5,391	186,151.23	34.53	34.53
10,781	293,573.93	27.23	19.93
16,172	385,274.84	23.82	17.01
21,563	464,037.35	21.52	14.61
32,344	599,674.91	18.54	12.58
43,126	749,113.43	17.37	13.86
53,908	920,223.77	17.07	15.87
	Opportunity Cost Model		
	---dollars---		
5,391	186,151.23	34.53	34.53
10,781	293,573.93	27.23	19.93
16,172	385,274.84	23.82	17.01
21,573	464,037.35	21.52	14.61
32,344	605,484.07	18.72	13.13
43,126	762,254.35	17.68	14.54
53,908	942,313.75	17.48	16.70

Table 3. Estimated rate schedule for transporting cotton by truck from gin to warehouse, Tennessee, 1976.

Distance	Cost per bale
miles	**dollars**
0.1 - 10.0	.72
10.1 - 20.0	.83
20.1 - 30.0	.99
30.1 - 40.0	1.10
40.1 - 50.0	1.21
50.1 - 65.0	1.37
65.1 - 80.0	1.54
80.1 - 100.0	1.65
100.1 - 125.0	1.76
125.1 - 150.0	1.87
Greater than 150.0	1.98

Source: This table was developed by adjusting and updating information first reported by Cleveland [1].

warehouses were assumed to have equal handling charges to eliminate bias over this expense and allow the model to select location based on transportation costs. The warehouses were also assumed to have 1,000,000 bale capacities (which effectively provided unlimited capacity), thus permitting the model to select size as well as location. Minimum levels of storage were not considered in this analysis.

Warehouse to Outlet Transfer Cost

Slightly more than half (54.9 percent) of the cotton shipped from Tennessee to domestic mills and export outlets was transported by rail in 1976. The remaining 45.1 percent was moved by truck [6]. However, no restrictions were placed on the model regarding the proportions transported by rail and truck. This permitted the selection of the most economically efficient transport mode. The costs of shipping cotton from the potential warehouse sites in Tennessee to the five outlets by rail and truck are presented in Table 4.

Outlet Demand

The most recent data available on the shipping patterns of cotton from Tennessee warehouses was from 1975 [4]. Examination of these shipping patterns for earlier periods revealed an extremely stable pattern. Based on this observation, the presumption was made that distribution of the 1976 cotton crop would be proportionately identical to the 1975 situation. The allocation of the 1976 crop to the domestic mills and export outlet, as presented in Table 5, served as the final demand requirements in the quantitative model.

FINDINGS

The model used in this study was basically a transshipment programming model modified to handle nonlinear processing cost functions. Models of this type, often referred to as yielding normative findings, are used to determine optimum solutions given an objective function and a set of relevant constraints. The optimum situation, for purposes of this study, was defined as: the seed cotton shipping patterns; gin locations, volumes, and length of season; warehouse locations and volumes; and ginned cotton shipping patterns which would minimize the total industry cost, given the model's specifications and constraints.

No-Opportunity Cost Model

The base model, referred to hereafter as the no-opportunity cost model, had fixed supplies and demands, and constant transfer costs between given points, and the commodity (480-pound bale equivalents) was considered

Table 4. Per bale cost of shipping cotton from Tennessee warehouses to selected outlets, by mode of transportation, 1976[a]

Potential Warehouse Locations	Port of New Orleans		Group 200 Mills[b]		Group 201 Mills[c]		Group 231 Mills[d]		Group 277 Mills[e]	
	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck
	dollars per bale									
Brownsville	4.464	4.25	7.200	6.00	6.624	5.50	6.096	5.00	5.568	4.25
Covington	4.272	4.25	7.200	6.00	6.624	5.50	6.096	5.00	5.568	4.25
Dyersburg	4.464	4.50	7.200	6.25	6.624	5.75	6.096	5.25	5.568	4.50
Henderson	4.464	4.25	7.104	6.00	6.432	5.50	5.376	5.00	4.560	4.25
Jackson	4.464	4.25	7.104	6.00	6.432	5.50	5.376	5.00	4.560	4.25
Memphis	4.272	4.25	7.104	6.00	6.432	5.50	5.568	5.00	5.088	4.25
Milan	4.464	4.25	7.200	6.00	6.624	5.50	5.376	5.00	5.376	4.25
Ripley	4.272	4.25	7.200	6.00	6.624	5.50	6.096	5.00	5.568	4.25
Tiptonville	4.464	4.50	7.200	6.25	6.624	5.75	6.096	5.25	5.568	4.50
Fayetteville	4.464	7.34	7.104	6.10	6.432	5.05	5.376	3.71	4.560	3.50
Murfreesboro	4.464	8.32	7.104	6.10	6.432	5.05	5.376	4.65	4.560	4.07

[a]Rail rates were supplied by the Memphis Cotton Exchange and truck rates were furnished by a truck brokerage firm.
[b]Refers to mills located in the eastern portion of North and South Carolina.
[c]Refers to mills located in the western portion of North and South Carolina.
[d]Refers to mills located in Atlanta and Cartersville, Georgia area.
[e]Refers to mills located in Anniston and Sylacauga, Alabama area.

homogeneous. Each potential gin site was represented by a separable cost function to determine the optimum gin size and season length. Warehouse storage capacities were specified so as to be completely unrestrictive regarding minimum or maximum values.

The no-opportunity cost model chose 17 of the 34 potential gin sites as part of the optimum cotton marketing organization (Figure 2). This optimum solution contained 13, 14-week gins and 4, 32-week gins. The 14-week gins processed 72,487 bales, while the 32-week gins processed 154,658 bales of Tennessee's 227,145 bales of cotton (Appendix Table 2). The average volume handled per hour ranged from 1 to 27 bales among the 14-week gins and from 21 to 29 bales per hour among the 32-week gins (Appendix Table 3).

The optimum solution included 9 of the 11 potential warehouse locations. The receipts by the warehouses ranged from 736 to 59,793 bales (Appendix Table 4). All cotton was transported by truck from warehouse to domestic mills and export outlets, except for 28,848 bales which moved by rail to Georgia mills (Figure 3 and Appendix Table 5.)

Table 5. Estimated shipments of cotton from Tennessee warehouses to domestic mills and export outlets, 1976.

Market Outlet	Cotton shipments	
	bales	percent
Group 200 mills[a]	69,279[f]	30.5
Group 201 mills[b]	69,279[f]	30.5
Group 231 mills[c]	28,848	12.7
Group 277 mills[d]	39,750	17.5
Export outlet[e]	19,989	8.8
Total	**227,145**	**100.0**

[a]Refers to mills located in the eastern portion of North and South Carolina.

[b]Refers to mills located in the western portion of North and South Carolina.

[c]Refers to mills in Atlanta and Cartersville, Georgia area.

[d]Refers to mills in Anniston and Sylacauga, Alabama area.

[e]Port of New Orleans.

[f]Available data did not distinguish between shipments to group 200 and 201 mills. For purposes of this study, the distribution of shipments to North and South Carolina was assumed to be proportionately equivalent.

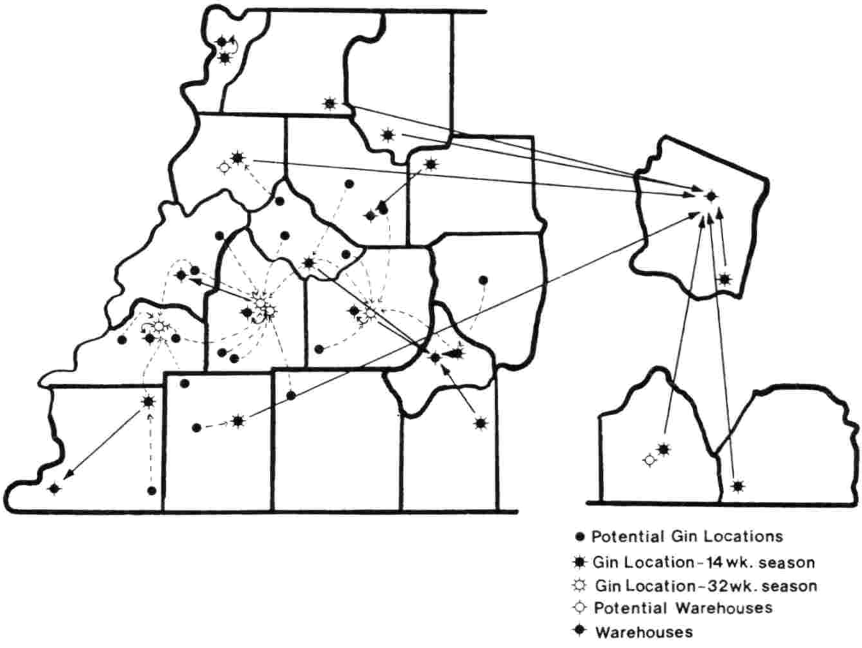

Figure 2. Location and Identification of Tennessee Cotton Gins and Warehouses, No Opportunity Cost Model.

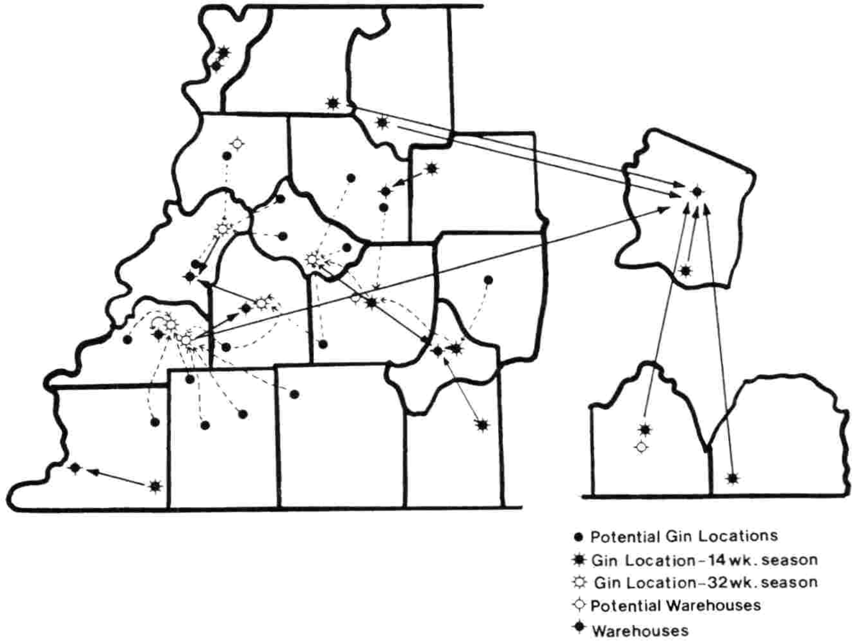

Figure 3. Location and Identification of Tennessee Cotton Gins and Warehouses, Opportunity Cost Model.

Opportunity Cost Model

A cost factor was incorporated into the base model to account for the opportunity cost on the cotton delayed from entering the marketplace due to an extended ginning season. Obviously, a least-cost gin operating 32 weeks would take over twice as long as a least-cost gin operating on a 14-week season, for a given volume of cotton. However, some economies of scale may be obtained by using a smaller gin and spreading the fixed cost. In most situations, the producer would have to wait longer before marketing the cotton, thus incurring an additional cost for the capital involved. To account for this opportunity cost, the ginning cost was increased by 10 percent of the borrowed capital.

The additional "opportunity cost" charge had minor impact on the optimum cotton marketing structure. The solution included 16 gins--1, 14-week gins and 5, 32-week gins (Figure 4 and Appendix Table 6). Eight warehouses were included in the solution (Appendix Table 7). The shipping pattern from warehouses to mills is shown in Figure 5 and Appendix Table 8. The differences in the no-opportunity and opportunity cost models appear to be the result of alternative optima within the tolerances set forth in the programming model rather than differences generated by the additional cost imposed for delayed merchandising. At the 10 percent interest level the impact on the optimum industry structure was negligible.

IMPLICATION AND CONCLUSIONS

An examination of the solutions obtained for the no-opportunity and opportunity cost models yields several implications for the future cotton marketing system in Tennessee. The solutions support the continuation of several trends apparent in the southern cotton region: 1) fewer and larger gins, 2) fewer warehouses, and 3) for cotton to continue moving by truck if rail rates do not become more competitive. The results obtained from the models suggest that a more efficient cotton marketing infrastructure is possible. Even with the addition of an opportunity cost, the extended ginning season was competitive with the 14-week season. This indicates that it also is a more cost-efficient system than presently exists in Tennessee.

The solutions also permitted the occurrence of extremely small volume gins, some operating at one bale per hour, or less. Logic would indicate a gin operating at such low volume is not efficient. It is highly likely that the 25-mile restriction on movements of cotton to gins forced the entry of isolated gins in small supply areas and that the removal of the 25-mile restriction would result in fewer small gins and heavier participation by larger gins. More importantly, the incidence of low volume gins may forewarn the cessation of cotton production and ginning activities in those supply areas.

This study does not advocate the immediate reorganization of the cotton marketing infrastructure. However, some insight into future adjustments

Figure 4. Shipping Pattern of Tennessee Cotton from Warehouses to Final Destinations, No-Opportunity Cost Model.

should be useful to industry decision-makers and governmental policymakers in formulating plans for the future. The data base used in this study was somewhat dated but the validity of the study as a policy tool should not be substantially diminished. A normative model, such as the one used in this study, does not account for the value of the present system, nor does it explain the transition cost of moving from the present system to the optimum system.

While the model used in this study did select the optimum least-cost industry organization, no attempt was made to fully evaluate potential benefits to the industry. Benefits should be substantial, but additional research is needed to accurately determine the potential savings associated with the optimum industry organization. Another weakness of the model was manifested when the model located several small gins in small supply areas in relatively close proximity to one another. The reason for this is that the algorithm is indifferent between equivalent increments in adjacent supply areas' processing curves because it uses a marginal selection criteria, and a constant processing charge is associated with all increments within a given segment. Thus, if the algorithm cannot get one of the processing centers into a more efficient segment by consolidation, it will yield a number of small centers. Care must be taken in selecting appropriate sized processing segments, and at the same time obtaining segments of sufficient size to insure a realistic evaluation of size and scale economies associated with the industry being evaluated.

Figure 5. Shipping Pattern of Tennessee Cotton from Warehouses to Final Destinations, Opportunity Cost Model.

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Appendix Table 1. Potential gin location specified for each Tennessee county and volumes of cotton produced in the designated supply areas.

Gin location by county and town	1976 Production Supply area	1976 Production County	Gin location by county and town	1976 Production Supply area	1976 Production County
	-----bales-----			-----bales-----	
Carroll County:		1,900	Henderson County:		920
Trezevant	1,900		Lexington	920	
Chester County:		1,800	Lake County:		8,000
Jacks Creek	1,800		Tiptonville	8,000	
Crockett County:		38,500	Lauderdale County:		11,600
Bells	9,625		Gates	5,800	
Friendship	9,625		Ripley	5,800	
Gadsden	9,625		Lincoln County:		1,800
Maury City	9,625		Fayetteville	1,800	
Dyer County:		11,000	Madison County:		15,200
Dyersburg	11,000		Jackson	7,600	
Fayette County:		24,100	Mercer	7,600	
Braden	8,033		McNairy County:		1,230
Oakland	8,033		Adamsville	1,230	
Somerville	8,034		Obion County:		2,240
Franklin County		975	Kenton	2,240	
Huntland	975		Rutherford County:		910
Gibson County		20,800	Fosterville	910	
Milan	10,400		Shelby County:		13,700
Trenton	10,400		Arlington	6,850	
Hardeman County:		7,600	Collierville	6,850	
Whiteville	7,600		Tipton County:		26,700
Haywood County		37,600	Gilt Edge	8,900	
Brownsville	9,400		Covington	8,900	
Brownsville	9,400		Charleston	8,900	
Stanton	9,400		Weakley County:		570
Stanton	9,400		Greenfield	570	
			Total Production	227,145	227,145

Appendix Table 2. Gin location, length of ginning season, and movement of cotton from Tennessee supply areas to gins, no-opportunity cost solution, 1976.

Length of ginning season and gin location	Total gin receipts	Supply areas	Shipments from supply areas
	bales		bales
14-Week Season:			
Trezevant	1,900	Trezevant	1,900
Jacks Creek	920	Lexington	920
Bells	10,400	Trenton	10,400
Dyersburg	20,625	Friendship	9,625
		Dyersburg	11,000
Somerville	16,067	Oakland	8,033
		Somerville	8,034
Huntland	975	Huntland	975
Tiptonville	8,000	Tiptonville	8,000
Fayetteville	1,800	Fayetteville	1,800
Kenton	2,240	Kenton	2,240
Fosterville	910	Fosterville	910
Arlington	6,850	Collierville	6,850
Greenfield	570	Greenfield	570
Adamsville	1,230	Adamsville	1,230
Subtotal	72,487		72,487
32-Week Season:			
Brownsville	36,062	Whiteville	7,600
		Brownsville	9,400
		Stanton	9,400
		Stanton	9,400
		Charleston	262
Brownsville	32,344	Bells	3,524
		Maury City	9,625
		Brownsville	9,400
		Gates	5,800
		Ripley	3,995
Jackson	43,126	Jacks Creek	1,800
		Bells	6,101
		Gadsden	9,625
		Milan	10,400
		Jackson	7,600
		Mercer	7,600
Covington	43,126	Braden	8,033
		Ripley	1,805
		Arlington	6,850
		Gilt Edge	8,900
		Covington	8,900
		Charleston	8,638
Subtotal	154,658		154,658
Grand Total	227,145		227,145

Appendix Table 3. Per hour ginning volumes of specified gains, by length of ginning season, for both the no-opportunity cost and opportunity cost solutions

Length of ginning season and gin location	Volume in bales per hour	
	No-opportunity cost solution	Opportunity cost solution
	bales	bales
14-Week Season:		
Trezevant	3	3
Jacks Creek	2	2
Bells	14	—
Dyersburg	27	—
Somerville	21	—
Huntland	2	2
Tiptonville	11	11
Fayetteville	3	3
Jackson	—	16
Kenton	3	3
Fosterville	2	2
Arlington	2	—
Collierville	—	9
Greenfield	1	1
Adamsville	2	2
32-Week Season:		
Bells	—	28
Brownsville	24	—
Brownsville	21	21
Gates	—	28
Jackson	28	—
Covington	29	22
Charleston	—	26

Appendix Table 4. Warehouse location and receipts from Tennessee gins in the no-opportunity cost solution, 1976.

Warehouse location[a]	Total receipts	Gin location	Shipments from gins
	bales		bales
Brownsville	8,613	Brownsville	8,613
Covington	43,126	Covington	43,126
Henderson	54,940	Jacks Creek	920
		Bells	10,400
		Jackson	43,390
		Adamsville	1,230
Jackson	736	Jackson	736
Memphis	6,850	Arlington	6,850
Milan	1,900	Trezevant	1,900
Ripley	59,793	Brownsville	27,449
		Brownsville	32,344
Tiptonville	8,000	Tiptonville	8,000
Murfreesboro	43,187	Dyersburg	20,625
		Somerville	16,067
		Huntland	975
		Fayetteville	1,800
		Kenton	2,240
		Fosterville	910
		Greenfield	570
Total receipts and shipments	227,145		227,145

[a]Two potential warehouse locations excluded from the solution -- Dyersburg and Fayetteville.

Appendix Table 5. Warehouse locations and shipments of Tennessee cotton to selected market destinations, no-opportunity solution, 1976.

Warehouse location	Port of New Orleans	Domestic mill group 200[a]	201[b]	231[c]	277[d]	Total shipments
	bales					
Brownsville	8,613					8,613
Covington	3,376				39,570	43,126
Henderson		26,092		28,848		54,940
Jackson			736			736
Memphis			6,850			6,850
Milan			1,900			1,900
Ripley			59,793			59,793
Tiptonville	8,000					8,000
Murfreesboro		43,187				43,187
Total shipments	19,989	69,279	69,279	28,848	39,570	**227,145**

[a]Refers to mills located in the eastern portion of North and South Carolina.

[b]Refers to mills located in the western portion of North and South Carolina.

[c]Refers to mills in the Atlanta and Cartersville, Georgia area.

[d]Refers to mills in the Anniston and Sylacauga, Alabama area.

Appendix Table 6. Gin location, length of ginning season, and movement of cotton from Tennessee supply areas to gins, opportunity cost solution, 1976.

Length of ginning season and gin location	Total gin receipts	Supply areas	Shipments from supply areas
	bales		bales
14-Week Season:			
Trezevant	1,900	Trezevant	1,900
Jacks Creek	920	Lexington	920
Huntland	975	Huntland	975
Tiptonville	8,000	Tiptonville	8,000
Fayetteville	1,800	Fayetteville	1,800
Jackson	12,200	Jacks Creek	1,800
		Milan	10,400
Kenton	2,240	Kenton	2,240
Fosterville	910	Fosterville	910
Collierville	6,850	Collierville	6,850
Greenfield	570	Greenfield	570
Adamsville	1,230	Adamsville	1,230
Subtotal	**37,595**		**37,595**
32-Week Season:			
Bells	43,126	Bells	9,625
		Gadsden	9,625
		Trenton	10,400
		Jackson	7,600
		Mercer	5,876
Brownsville	32,344	Brownsville	9,400
		Brownsville	9,400
		Stanton	2,420
		Stanton	9,400
		Mercer	1,724
Gates	41,850	Friendship	9,625
		Maury City	9,625
		Dyersburg	11,000
		Gates	5,800
		Ripley	5,800
Covington	32,683	Braden	8,033
		Arlington	6,850
		Gilt Edge	8,900
		Covington	8,900
Charleston	39,547	Oakland	8,033
		Somerville	8,034
		Whiteville	7,600
		Stanton	6,880
		Charleston	8,900
Subtotal	**189,550**		**189,550**
Grand total	**227,145**		**227,145**

Appendix Table 7. Warehouse location and receipts from Tennessee gins in the opportunity cost solution, 1976.

Warehouse location[a]	Total receipts	Gin location	Shipments from gins
	bales		bales
Brownsville	19,056	Brownsville	13,665
		Charleston	5,391
Covington	32,683	Covington	32,683
Henderson	57,476	Jacks Creek	920
		Bells	43,126
		Jackson	12,200
		Adamsville	1,230
Memphis	6,850	Collierville	6,850
Milan	1,900	Trezevant	1,900
Ripley	60,529	Brownsville	18,679
		Gates	41,850
Tiptonville	8,000	Tiptonville	8,000
Murfreesboro	40,651	Huntland	975
		Fayetteville	1,800
		Kenton	2,240
		Fosterville	910
		Charleston	34,156
		Greenfield	570
Total receipts and shipments	**227,145**		**227,145**

[a]Three potential warehouse locations excluded from the solution -- Dyersburg, Jackson, and Fayetteville.

Appendix Table 8. Warehouse locations and shipments of Tennessee cotton to selected market destination, opportunity cost solution, 1976.

Warehouse location	Port of New Orleans	Domestic mill group 200[a]	Domestic mill group 201[b]	Domestic mill group 231[c]	Domestic mill group 277[d]	Total shipments
	bales					
Brownsville	11,989				7,067	19,056
Covington					32,683	32,683
Henderson		28,628		28,848		57,476
Memphis			6,850			6,850
Milan			1,900			1,900
Ripley			60,529			60,529
Tiptonville	8,000					8,000
Murfreesboro		40,651				40,651
Total shipments	19,989	69,279	69,279	28,848	39,750	**227,145**

[a]Refers to mills located in the eastern portion of North and South Carolina.

[b]Refers to mills located in the western portion of North and South Carolina.

[c]Refers to mills in the Atlanta and Cartersville, Georgia area.

[d]Refers to mills in the Anniston and Sylacauga, Alabama area.