ESTIMATING THE POTENTIAL IMPACT
OF THE MODULE BUILDER
ON THE NUMBER AND SIZE OF GINS

by

Kenneth W. Paxton
Yuan Chen

Professor and Graduate Student,
Department of Agricultural Economics and Agribusiness
Louisiana Agricultural Experiment Station
LSU Agricultural Center
Baton Rouge, LA

Presented at the 1994 Beltwide Cotton Conferences

ESTIMATING THE POTENTIAL IMPACT OF THE MODULE BUILDER ON THE NUMBER AND SIZE OF GINS

K.W. Paxton and Yuan Chen
Professor and Graduate Student, respectively
Department of Agricultural Economics and Agribusiness
Louisiana State University Agricultural Center
Baton Rouge, LA

Abstract

The module builder system has improved the timeliness of the harvest operation. In addition, the storage potential of the module enables cotton gins to extend the ginning season and gin larger volumes of cotton. Because larger volumes generally imply lower average ginning costs, there are some incentives for gins to seek additional cotton. This study examines the trade-offs between the reduced costs from additional volume and the added costs associated with obtaining the extra volume. As individual gins increase volume, fewer gins will be required to gin existing production. Results obtained here suggest that there will be increasing economic pressure on gins to obtain larger volumes to reduce costs. Gins unable or unwilling to attract additional volume will be at an economic disadvantage relative to other gins in the industry.

Introduction

The cotton gin is a vital component of the infrastructure required in the production and marketing of cotton and its by-products. The gin provides an initial transformation of raw seedcotton into the primary products of cotton lint and seed. The structure of the cotton ginning industry is continually changing in response to increases in operating cost, shifts in location of production, technological changes, and construction of newer high-capacity facilities.

One of technological changes influencing gins has been the seedcotton handling systems used by producers. Traditionally, seedcotton was placed in trailers and hauled to the gin. While the trailer has provided efficient low-cost transportation over short distances, it has limited storage ability. The introduction of the module handling system offered an alternative mode of transport for seedcotton. Cost of transportation for the module is typically higher for shorter distances (under 10 miles) and lower over longer distances. In addition to transporting seedcotton, the module can be used to store seedcotton for extended periods. This storage function, along with the cost advantage for hauling longer distances, has implications for the number and size of gins. The storage ability of the module not only permits a more timely harvest of seedcotton, but it also permits the gin to extend the ginning season.

Extending the ginning season allows smaller gins to gin additional cotton, thus lowering their processing costs. Further, the longer storage and hauling abilities may tend to encourage the construction of larger gins (gins with greater processing capacity per unit of time). Larger gins can also take advantage of the storage function of modules and operate at a higher level of efficiency. By extending the ginning season, average ginning costs are lowered and the area over which the gin obtains cotton expands.

As the proportion of cotton ginned from modules increases, there will be an associated increase in pressure for change within the ginning industry. Therefore, information will be needed to assist the industry in making adjustments. Specifically, this study proposes to provide an estimate of the potential impact of the module builder on the number, size, and location of gins within Louisiana.

Objectives

The overall objective of this paper is to determine the potential impact of increased module builder use on the structure of the ginning industry in Louisiana.

The specific objectives are:

1. To identify the current structure of the ginning industry in Louisiana.
2. To determine the change in the number and size of gins and the associated change in module builder utilization.

Procedures

General Procedure

Data on cotton production and existing number, size, location, and processing capacity of gins were obtained for each Louisiana parish from the USDA cotton classing office in Rayville, Louisiana. A Geographic Information System (GIS) model was developed utilizing the production and processing data. Cost functions for assembling and ginning seedcotton were estimated using the MATLAB (Matrix Laboratory) software program. The functions for the current distribution pattern and the optimal distribution pattern that minimizes the combined costs of assembly and ginning were simulated using the MATLAB software package. The optimal utilization of the cotton module builder was selected by using the optimal distribution pattern to minimize combined assembly and ginning costs.

Specific Procedures

The first objective was to identify the current structure of the ginning industry in Louisiana. This objective was accomplished with secondary data obtained from the USDA Cotton Classing Office, Rayville, Louisiana. The GIS was used to present graphic reports showing the major producing areas in Louisiana.

The second objective was to determine change in the number and size of gins and the associated change in module builder utilization in Louisiana. Historical data were obtained on the proportion of cotton ginned from trailers and modules for the period 1979-91.

The cost of assembling and ginning seedcotton under the current structure of the ginning industry was determined. This served as the baseline against which potential impacts were measured. These costs were expressed as a function of distance hauled. Transportation costs for conventional trailers were based on estimated costs of owning and operating the trailers and tow vehicle. Costs of transporting modules were based on custom charges for hauling.

Ginning costs were estimated from secondary sources. Data from Mayfield were used to estimate the impact of increases in volume on ginning costs. The baseline model assumed 1991 volume and ginning costs. A functional relationship between the distance and ginning volume was established, using the database in GIS. The above two functions were generated using the simulation approach in the MATLAB software package. By combining the functional relationship between ginning cost and ginning volume with the functional relationship between ginning volume and distance, a relationship between the ginning cost and distance was established.

The distribution function of ginning volume relative to distance hauled, for the current situation, was simulated using MATLAB. By generating different distribution functions to fit the data, the best fit distribution function was selected, with the mean and standard deviation and its shape most identical with those of the data. The optimal distribution function that minimized the combined assembly and ginning costs was selected by systematically varying the parameters in the distribution function for the current situation.

Finally, the analytical model for determining number, size, and location of gins was established by combining the transportation model and ginning model. The analytical model required statements of the combined assembly and processing costs to distance, which was achieved by summing the assembly cost model and processing cost model. The optimization solution to the analytical model that minimized the combined costs of assembly and ginning was generated, using the optimal distribution pattern in the analytical model.

Two scenarios were expressed within the model. A baseline model that represented the assembly and processing costs of the ginning industry for 1991 was developed. The second scenario removed restrictions on mode of transportation, gin size, and location to determine the optimum number, size, and location of gins in Louisiana.

Structure of the Louisiana Ginning Industry

Data on cotton production and existing number, size, and location of gins were obtained for each Louisiana parish from the USDA cotton classing office in Rayville, Louisiana. The Geographic Information System (GIS) was utilized to digitize the existing data and to analyze the database, which included graphic (linework and maps) and nongraphic (database) components.

The number and size distribution of cotton gins in Louisiana are presented in Table 1. Cotton gin size is usually expressed in terms of the manufacturer's rated capacity or the maximum number of bales which can be ginned per hour under ideal operating conditions. This can range from a low of 2-3 bales per hour to 35 or more bales per hour. Data available for this study were the number of bales ginned in 1991. Since the volume of cotton ginned in 1991 was relatively high, this volume may be taken as a proxy for ginning capacity on an annual basis. The cotton volume ginned per year is directly related to the rated capacity. Normally, a gin operates at 85 percent of its efficiency, and the average industry standard for a gin is to operate 906 hours/year. For example, a gin with a rated capacity of 20 bales per hour has an effective capacity of 17 bales per hour. In a normal year operating 906 hours, the gin processes approximately 15,402 bales. As can be seen in Table 1, approximately 50 percent of the gins in Louisiana ginned less than 15,000 bales each.

Table 2 shows the volume of cotton ginned by size of gin. While gins with less than 15,000 bales account for 50 percent of the gins, they account for 39 percent of the total cotton ginned. Larger gins (over 35,000 bales) account for about 10 percent of the number of gins, but handle almost 27 percent of the volume.

The relative change in mode of transporting seedcotton to the gin is shown in Table 3. Conventional cotton trailers were the dominate mode of transport until 1990. The percentage of cotton ginned from modules has increased dramatically in recent years. Even with this increase, the percentage of cotton ginned from modules in Louisiana is below the national average. This implies that additional adjustments are possible in Louisiana.

Transportation Model

After harvest, Louisiana cotton is either moved directly to the gin in trailers or compressed into modules. Modules may move immediately to the gin or be held temporarily on the farm or at the gin if gin delays are excessive. Traditionally, the most common method of assembling seedcotton at the gin is a four-wheel cotton trailer pulled behind an empty pickup truck. Ten-bale trailers are quite common and are the usual size supplied to farmers by cotton gins. More recently, the cotton module system, with each module builder containing 10 to 15 bales of seedcotton, has become more prominent. This section develops the transportation cost functions for trailers and modules.

Assembly Costs for Cotton Trailer

Assembly costs for the cotton trailer are expressed as a function of distance hauled. Fixed costs include depreciation and interest on investment for the trailer; variable costs include direct cost for the cotton trailer, and direct cost for the pickup truck (gas consumption, repairs, lubrication, and labor cost). Ownership costs for conventional trailers were taken from enterprise budget publications (Paxton and Lavergne, 1992).

The purchase price of the trailers was assumed to be \$7,600. Total life was estimated to be 3,000 hours (or 15 years at 200 hours per year). Total fixed costs (depreciation, interest, and investment) for 10-bale cotton trailers were estimated to be \$506 per year. Each trailer was assumed to make approximately 15 trips to the gin each year, hauling approximately 150 total bales. Therefore, the fixed costs per bale were \$3.33 (\$506/150 = \$3.33).

Variable costs for trailers were estimated to be \$1.47 per hour for the conventional 10-bale trailers. Since a 10-mile round trip for the 10-bale cotton trailers usually takes one hour (Paxton and Lavergne), variable costs for the 10-bale cotton trailer were \$0.0147 per bale per hour per mile.

Direct cost for the pickup truck tow vehicle was estimated at \$3.36 per hour. The price of gas was estimated at \$1.30 per gallon. Fuel costs were estimated based on fuel requirements of 5 mpg per loaded mile and 10 mpg per unloaded mile. Therefore, 10 bales being hauled to the gin, consumed gas at the rate of 5 mpg at 20 mph, and coming back unloaded from the gin, gas was consumed at the rate of 10 mpg at 40 mph. The estimated repair cost was \$0.007 per mile per bale. The estimated cost for lubrication was 15 percent of gas costs. Labor costs were estimated to be \$7 per hour.

The calculation of transportation costs for the cotton trailer is divided into three stages: (1) hauling to the gin, (2) returning from the gin, and (3) weighing in at the gin. For the first stage, hauling the cotton to the gin, 10 bales being hauled to the gin requires approximately 0.2 gallons of gas and three minutes per mile. Lubrication cost was estimated to be 15 percent of fuel costs. Therefore, the lubrication and fuel cost were 1.15 × gas/50 per mile per bale (50 is the number of bales hauled per gallon: 5 mpg × 10 bales/trailer = 50). Repairs were estimated to be \$0.007 per mile.

For the second stage, the cotton trailer returns unloaded from the gin. The tow vehicle (pickup truck) consumes gas at the rate of 10 mpg at a speed of 40 mph. Therefore, each mile will require 0.1 gallon of gas and 1.5 minute of time. In the third stage, it is assumed that it takes 15 minutes for the trailer to check in at the gin. The cost of this stage is the fixed cost of the cotton trailer and the cost of labor per hour per bale.

These cost components can be stated algebraically as a sum, which is the assembly cost for the cotton trailer.

$$TR_t = 3.5208 + 0.1478X \tag{1}$$

Here, TR_t is the dependent variable of the transportation cost per bale, and X is distance in miles.

Assembly Cost Function for Cotton Module Builder

An assembly cost function was developed using published farm-to-gin cost data and information (Lavergne, Paxton, and Giesler, 1993). Costs of transporting modules were based on custom charges for hauling. The assembly cost function for the module was estimated to be a function of the mileage between the farm and the gin:

$$TR_m = 3.75 + 0.125X \qquad (2)$$

where:

TR_m = farm to gin assembly cost per bale for modules
3.75 = fixed cost associated with all farm to gin shipments
0.125 = variable cost per mile per bale for farm to gin assembly
X = mileage between producing area and gin location

Analysis of Assembly and Processing Cost

Combined assembly and ginning costs display the same characteristics as ginning costs alone when cotton is hauled a fixed distance. As hauling distance increases, assembly costs increase. Beyond a certain distance, the cost of hauling additional cotton to the gin may be greater than the savings derived from ginning the additional volume. This may cause combined assembly and ginning costs to increase for cotton hauled beyond some specified distance.

The analytical model, requiring statements of the combined assembly and processing costs, is developed by combining the transportation cost model and ginning cost model through a distance distribution model. First, the distance distribution pattern for the current situation is used to develop a distance distribution model (function). This information is combined with a function depicting ginning costs as a function of volume ginned. By varying the distance distribution model, alternative solutions can be determined for various distances hauled and volumes processed. The system can be optimized by discovering the distance distribution and volume that yields the minimum total assembly and processing costs. The distance distribution model contains alternative models of transport (trailers and modules). The proportion of cotton moving via each is varied to determine the optimal mix.

Processing Cost Model

A functional relationship between the ginning volume and the average ginning cost was established using data from Mayfield's article on "Cost of Ginning Cotton," presented at the 1992 Beltwide Cotton Conference. This cost function expresses the technical relationship between the level of input and cost. Hence, the selection of an algebraic functional form is the one that is known to be or approved to be consistent with the phenomena (Heady and Dillon, 1972).

$$\begin{array}{llll} PC = 0.018V^2 & - 1.695V & + 71.9493 & \qquad (3) \\ \quad (65.8) & (-110.5) & (393.7) & \end{array}$$

$$R^2 = 0.9, \qquad F = 267415.1$$

where:

PC = average ginning cost in dollars per bale

V = is the capacity or the ginning volume in thousand bales

Alternative functional forms, such as the linear and log-linear functions, were also tested to fit the data. The results of the T-test and F-test suggest that the quadratic function is the best.

Relationship between Ginning Volume and Distance

A functional relationship is established between the ginning volume and the distance cotton is hauled to the gin. A nongraphic report, developed by the Geographic Information System (GIS), which shows the cotton gins, including number, size, and location, in Louisiana was used in developing the functional relationship between ginning capacities and distance. The ginning volume data is secondary data, the distance is calculated using the coordinates of the gin locations digitized in GIS.

$$\underset{(22.9)}{V = 0.0017X^2} + \underset{(37.3)}{0.148X} + \underset{(60.7)}{2.9404} \tag{4}$$

$$R^2 = 0.9, \qquad F = 171778$$

where:

X = is the average distance in miles from a cotton farm to a gin, and

V = is the volume of cotton per gin in thousand bales.

Relationship between Ginning Cost and Distance

A functional relationship can be established between the distance and the processing cost. This function is estimated from the above two functions. The equation is shown as:

$$PC = \underset{(1156)}{0.2764X^2} - \underset{(-1548.4)}{7.4762X} + \underset{(3641.6)}{82.3947} \tag{5}$$

$$R^2 = 1, \qquad F=111489440.7$$

where:

PC = the average ginning cost in dollars per bale, and

X = the average distance in miles to go to a gin.

Alternative functional forms, such as the linear function, were also tested to fit the data; results of the T-test and F-test suggest that the quadratic function is the best.

Distance Distribution Model

The simulation of economic systems has evolved as one of the most interesting and potentially powerful tools available for analyzing economic problems.
Experimentation by means of computer simulation can overcome some of the restrictions that exist when other forms of analysis are used. This opens up the possibility of dealing with a process too complex to be represented by more rigid mathematical models, such as linear programming and calculus maximization and minimization models. Simulation may make possible experiments to validate theoretical prediction of behavior in cases where experimentation on the system under study would be impossible, prohibitively expensive, or complicated by the effects of interaction of the observer with the system under study.

Using data of the current distribution, the mean of the current distribution pattern is calculated to be 10, the variance of the data is 25, and the standard deviation is 5. One of the characteristics of this distribution is that the standard deviation is half of the mean. Once the mean and the variance of a distribution are known, parameters of the functional forms of that distribution can be found. Therefore, by using the existing mean and variance to solve the parameters in the normal distribution, the functional form of the normal distribution is established. The results indicate that the Gamma distribution best fits the data, since the Gamma distribution demonstrates the least discrepancies from the raw data (which can be found by the least squares rule). The function form of the Gamma distribution is as follows:

$$Y_X = \frac{1}{\Gamma(\alpha)\beta^{\alpha}} X^{\alpha-1} e^{-\frac{X}{\beta}} \tag{6}$$

where:

Y_x = probability density with respect to x;
X = hauling distance from the cotton producing area to the ginning location;
α = parameter;
β = parameter;

The Gamma function is:

$$\Gamma(\alpha) = \int_0^{\infty} t^{\alpha-1} e^{-t} dt \tag{7}$$

where:

dt = integral unit

Here the mean of the gamma distribution is:

$$Mean = \alpha\beta \tag{8}$$

The variance of the gamma distribution is:

$$Variance = \alpha\beta^2 \tag{9}$$

The standard deviation is the square root of the variance. Since the data representing the current distribution pattern has a mean of 10 and a standard deviation of 5, parameters of the gamma distribution can be solved. Therefore, for the current distance distribution pattern the Mean=$\alpha\beta$=10; Variance=$\alpha\beta^2$=25; Therefore, α=4, β=2.5.

Analytical Model for Current Ginning Structure

The analytical model solution for the current situation is given by the combined assembly and ginning costs through the current distance distribution pattern.

Assume the following:
TC = total processing and assembly costs per bale;
TAC = average assembly costs;
TPC = average processing costs;
PC = processing cost function;
X = distance between the producing area and gins;
Y_x = distribution density function;
TR_t = assembly costs using cotton trailer;
TR_m = assembly costs using cotton module builder;
dis = critical distance where the assembly costs of using the cotton trailer equals that of using the cotton module builder;
The assembly cost relationship is stated as:

$$TAC = \sum_{X=1}^{dis} TR_t(X)Y_X + \sum_{X=dis+1}^{\infty} TR_m(X)Y_X \tag{10}$$

The processing cost relationship is expressed as:

The analytical model is obtained by using the distance distribution model to sum up the above

$$TPC = \sum_{X=1}^{\infty} PC(X) * Y_X \tag{11}$$

two relationships. The equation is stated algebraically below.

$$TC = TAC + TPC = \sum_{X=1}^{dis} TR_t(X) Y_X + \sum_{X=dis+1}^{\infty} TR_m(X) Y_X + \sum_{X=1}^{\infty} PC(X) * Y_x \tag{12}$$

where:

Y_x is equation 6

The above equation is the functional form of the gamma distribution, where the mean of the gamma function is $\alpha\beta$ and the variance is $\alpha\beta^2$.

The combined assembly and ginning costs for the current situation is determined by putting the current distribution pattern into the equation of the analytical model. Under the current situation, the average distance hauled is 10 miles and the combined assembly and ginning cost is $45.75 per bale. Since the total ginning volume is estimated at 1,354.368 bales, the total ginning costs for the current situation is about 62 million dollars.

Optimizing Analytical Model Using Simulation Approach

The optimal analytical model that minimizes combined assembly and processing costs is obtained by finding the optimal distance distribution.

The optimal distance distribution pattern is selected in two steps. First, the mean of each distance distribution pattern is changed from 7 miles to 55 miles in increments of 1.2 miles (a total of 40 steps). Then each distribution generated from this simulation is brought into the analytical model to find the combined assembly and ginning costs for each of these distribution patterns. The mean of the optimal distribution is between 7 and 55 miles, since cotton normally is hauled an average of 10 miles. The purpose of the above procedure is to generally locate the optimal distribution pattern. Second, the mean of each distribution is changed from 7 miles to 20 miles in increments of 0.323 miles (a total of 40 steps), with the standard deviation being half of its mean. Each distribution generated is then brought into the above analytical model to find the combined assembly and ginning costs. The purpose of this last step is to find the exact location of the optimal distribution pattern that minimizes the combined assembly and ginning cost.

By putting the optimal distribution pattern into the equation of the analytical model, the analytical model under the optimal situation can be solved. The combined assembly and ginning costs were $43 per bale, which is $2 lower than the combined assembly and ginning costs under the current distribution pattern. Since the total ginning volume is 1,354,368 bales, the total ginning costs can be reduced by about 2.64 million dollars (1,354,368 bales × $2 = 2.64). In addition, the utilization ratio of the cotton trailer to the cotton module builder decreases from 4:6 to 3:7, a 10 percent increase in the current utilization of the cotton module builder.

Under the optimal situation, the minimized combined assembly and ginning cost is $43 per bale. The optimal average distance hauled is 15 miles compared to ten miles under the current distance distribution pattern. About 56.6 percent of the seedcotton is hauled to a gin within 10 miles under the current situation. However, only 27.2 percent of the seedcotton is hauled to a gin within 10 miles under the optimal situation. The assembly cost of the cotton trailer is more expensive than that of the cotton module for distances greater than 10 miles. The optimal utilization of the cotton trailer is for distances under 10 miles, which accounts for 27.2 percent of total seedcotton movements. Therefore, the optimal utilization of the cotton trailer to the cotton module is 27.2 percent to 72.8 percent.

Conclusions

Most of the cotton production in Louisiana is concentrated in the northeast area, and cotton gins are generally evenly distributed throughout these areas. Therefore, most of the gins are located in the northeast area.

While the general distribution of gins is fairly even across the production area, the size distribution of gins is not even. Larger gins are mostly located in northeast Louisiana, with smaller gins located in Red River Valley and Macon Ridge areas. Historically, smaller gins ceased operation. Surviving gins have tended to increase capacity levels to accommodate larger cotton crops. These trends are expected to continue.

The increasing use of the cotton module builder as a seedcotton handling system has contributed to the increased volume per gin. As shown in this study, transport via modules is cheaper for distances greater than 10 miles. Results of the analysis in this study demonstrated that moving more cotton in modules and hauling long distances could reduce costs. While assembly costs increase with larger hauling distances, processing costs are reduced such that the combined costs are reduced. Under the optimal situation, the average hauling distance was 15 miles, while the current average distance was 10 miles. Accordingly, the use of modules is expected to increase up to 73 percent in Louisiana, a 21 percent increase over the 1990 utilization.

Based on the optimal distance distribution pattern, the minimized combined assembly and ginning costs is $43 per bale, which is $2 lower than the currently combined assembly and ginning costs. Since the total ginning volume is 1,354,368 bales in Louisiana, the total savings to the ginning industry is about 2.64 million dollars.

Implications

Since seedcotton is hauled longer distances under the optimal structure, smaller gins are at greater risk of being forced out of business. Under the current situation, 56.6 percent of the seedcotton is transported 10 miles or less, and all the cotton being hauled 10 miles or less is transported by trailers. However, under the optimal situation, only 27.2 percent of the seedcotton is estimated to be hauled 10 miles or less to the gin. The increasing utilization of modules permits hauling seedcotton longer distances. In the optimal situation, 29.4 percent (56.6 percent - 27.2 percent) of all the cotton will be hauled longer than 10 miles and a loss of about 400,000 bales (29.4 percent × 1,354,368 total ginning volume) will occur to the gins within 10 miles of the cotton producing areas. As can be shown in Figure 4.2, the gins within 10 miles of the cotton producing areas are mostly gins rated under 35,000 bales per year. These are the gins most likely to be affected by this change. The gins rated under 35,000 bales per year processed 922,355 bales in 1991. The loss of bales to these gins is about half of their ginning volume (400,000 / 922,355). Approximately 65 gins rated less than 35,000 bales per year are operating under the current situation. Among these 65 gins, 40 gins are rated under 20,000 bales. The 40 gins rated under 20,000 bales will have to compete directly with the gins rated above 20,000 bales and below 35,000 bales, since the percentage of cotton hauled less than 10 miles will be smaller. Smaller gins usually have higher operation costs and have a higher risk of suffering severe loss or going out of business under the optimal situation. On the other hand, about 400,000 bales will be hauled over 10 miles by the modules, and larger gins rated over 35,000 bales per year are mostly located beyond 10 miles of the producing areas. More business opportunities will be available for larger gins.

REFERENCES

Covey, Charles D., Cotton Gin Efficiency as Related to Size, Location, and Cotton Production Density in Louisiana, unpublished M.S. Thesis, Baton Rouge, Louisiana State University, June 1963.

Fondren, T. H., Stennis, E. A., and Lamkin, C. J., Optimum Organization of Gins and Warehouses for Marketing Cotton in Missouri, Beltwide Cotton Conference, 1981.

Glade, E. H., and Johnson, M. D., Commodity Economics Division, Economic Research Service, USDA, ERS Staff Report AGES 9065, Oct. 1990.

Heady, E. O. and Dillon, J. L, Agriculture Production Functions, Lowe State Press, 1972., Ch. 2 and 3.

Hudson, J. F., and Cocheba, D., Costs of Cotton Lint and Cottonseed Shipments from Gins to Warehouses and Oil Mills in Louisiana, Bulletin No. 605, December 1965. Department of Agricultural Economics and Agribusiness, Louisiana State University.

Hudson, J. F., and Jesse, R. H., Optimum Number, Size, and Location of Processing Facilities for More Efficient Marketing of Louisiana Cotton. Department of Agricultural Economics and Agribusiness, Research Report No.438, June 1972, Louisiana State University.

Lavergne, D. R., Paxton, K. W., and Gauthier, W. M., The Changing Structure of the Louisiana Cotton Ginning Industry, Department of Agricultural Economics and Agribusiness, Louisiana Agricultural Experiment Station, 1991.

Lavergne, D. R., Paxton, K. W., and Giesler, G., Costs and Efficiencies of Alternative Cotton Harvesting Systems, 1993 Beltwide Cotton Conferences, P489-P493.

Law A. M., and Kelton, W. D., Simulation Modeling and Analysis, McGraw-Hill, 1982, Ch. 3.

Mayfield, W., Cost of Ginning Cotton, National Program Leader, Cotton Mechanization Service, USDA, 1992.

Paxton, K. W., and Lavergne, D. R., Projected Costs and Returns—Cotton, Soybean, Corn, Milo, and Wheat, A.E.A. Information Series No. 99, Northeast LA, Jan., 1992.

USDA Cotton Classing Office, Rayville, Louisiana, Oct., 1991.

USDA Forest Service, The Application of the Geographical Information System, 1986.

Westberry G. O., and Mills, F. D., More Cotton—More Gins? University of Georgia, Cooperative Extension Service, Tifton, Georgia, 1989.

Table 1. Number of Gins and Proportion of Cotton Production Ginned from Trailers and Modules, Louisiana, 1979-1990.

Year	No. Gins	Trailers (Percent)	Modules (Percent)
1979	117	93	7
1980	98	97	3
1981	98	93	7
1982	95	92	8
1983	92	94	6
1984	93	94	6
1985	89	93	7
1986	84	96	4
1987	84	84	16
1988	82	80	20
1989	81	68	32
1990	81	49	51
1991	85	49	51

Source: Glade and Johnson, Commodity Economics Division, Economic Research Service, USDA, ERS Staff Report AGES 9065, October 1992 and previous years.

Table 2. Size Distribution of Louisiana Cotton Gins, 1991.

Size (Bales/Year)	Number	Percentage	Accumulative Percentage
Under 5,000	6	8.11	8.11
5,000 - 10,000	17	22.97	31.08
10,000 - 15,000	14	18.92	50.00
15,000 - 20,000	13	17.57	67.57
20,000 - 25,000	7	9.46	77.03
25,000 - 30,000	4	5.41	82.43
30,000 - 35,000	4	5.41	87.84
35,000 - 40,000	2	2.70	90.54
40,000 - 45,000	3	4.05	94.59
45,000 - 50,000	1	1.35	95.96
Over 50,000	3	4.05	100.00
Total	74	100.00	

Source: USDA Cotton Classing Office, Rayville, Louisiana, October 1991.

Table 3. Ginning Volume Distribution of Louisiana Cotton Gins, 1991.

Size (Bales/Year)	Ginning Volume (Bales/Year)	Percentage	Accumulative Percentage
Under 5,000	13,292	0.98	0.98
5,000 - 10,000	120,141	8.88	9.82
10,000 - 15,000	172,507	12.74	22.59
15,000 - 20,000	220,841	16.31	38.90
20,000 - 25,000	155,796	11.50	50.40
25,000 - 30,000	106,699	7.89	58.28
30,000 - 35,000	133,079	9.83	68.10
35,000 - 40,000	72,509	5.35	73.46
40,000 - 45,000	126,463	9.34	82.79
45,000 - 50,000	46,839	3.46	86.25
Over 50,000	186,202	13.75	100.00
Total	1,354,368	100.00	

Source: USDA Cotton Classing Office, Rayville, Louisiana, October 1991.