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Assembling, Storing and Ginning Cotton in the Mississippi Delta

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Seed Cotton: Assembling, Storing, and Ginning in the Mississippi Delta

The cotton ginning industry in the Delta states is presently at what might well be the most decisive period in its development. There are many problems facing the industry. Some of these problems are being brought about by shifts in cotton production from one area to another, the rapid increase in the use of mechanical harvesting techniques in the past decade, low annual volume per gin, the ever increasing investment in plant, and many others. The ginning industry is characterized by relatively high per unit costs of operation, the result of large investment and low annual volumes of output.

Since 1917, the number of gins has decreased from 5.25 thousand to 1.8 thousand in 1963. During the same period cotton production in the five Delta states increased from an average of 2.65 million bales in 1912-17 to an average of 4.76 million bales in 1959-63. The result has been larger annual volumes per gin. Recently, "high capacity" gin stands have been developed to handle several times the hourly volume of the old type stand. As a result, many of the old type gins are being remodeled to include some of the "high capacity" equipment, some are being completely replaced by new, totally modernized units, and others will remain in operation with few, if any, changes.

This report provides a basis for evaluation of the various problems or alternatives which the ginning industry faces in meeting the challenges of the future. The report combines segments of the entire problem which have been assembled by members of the Southern Regional Marketing Committee, SM-24, from the Delta states—Arkansas, Louisiana, Tennessee and Missouri. This study viewed the over-all marketing channel for cotton as it moves from the farm to the mill.

The objectives of the study included investigating all aspects of this marketing channel with the thought in mind of reducing the marketing costs through greater efficiency, alternative physical channels, or other methods. While certain members of the Delta Sub-Group did devote their efforts toward investigating the merchandising aspects of cotton, most of the effort was devoted toward the gin complex. The materials herein include a detailed study on (1) the costs of transportation of seed cotton from the farm to the gin with different densities of production and location of gin plants, (2) the feasibility and cost of storing seed cotton prior to ginning as a means of increasing the volume ginned through delayed ginning, (3) the costs of modernizing existing gin plants, and (4) the costs and returns from the replacement of existing plants with high-speed, high capacity plants.

Many problems arise in combining studies that have been conducted under different conditions. Most of these problems are somewhere evident in trying to combine different segments in this report. A major problem incurred throughout this publication is concerned with the rate and time dimensions of cotton gin operations.

The conventional marginalistic economic theory of production recognizes output variations in plant operations. Conventional theory does not, however, differentiate between output variations of the time and rate.[1] *Rate variation* refers to plant output variations brought about by varying the rate of production in a given time period. *Time variation* refers to plant output variations where rates of output are held constant and the number of hours the plant is operated is varied. Holding the rate of output constant while varying the output through the time dimension will produce constant marginal costs. This follows automatically from the fact that if rate of output remains constant, plant efficiency also remains constant and thus variable costs remain constant.[2]

The rate dimension refers to plant output variation where time is held constant and the rate of processing is varied. This type of output variation results in the traditional marginal cost curve. This type of output variation by necessity occurs when existing plants are modernized for increasing the capacity. This type of variation was found in the section concerned with modernizing plants.

The cotton ginning industry provides a prime example of cost curves that are almost perfect reflection of variation in output through hours of operation (time). This situation is violated when certain new technologies are included such that the rate of output per hour varies with different intensive uses of new technology. For technical reasons, cotton gins normally operate at constant rates and vary hours of operation to accommodate available volume. Exceptions to this situation are relatively unimportant but may be brought about by (1) lack of sufficient cotton to keep all gin stands in production, (2) overtime pay for increased hours of work, and (3) inefficient, inexperienced "night crews." However the

[1]For more detailed discussion on time (vs. rate) dimension see B. C. French, *et. al.*, "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears," *Hilgardia,* XXIV (July, 1956), 548-9.

[2]Marginal costs, being associated with the degree of change in variable costs, will, therefore, remain constant and variable costs will not change. Variations in output due to time variations will provide linear total cost functions. Conventional marginal analyses applied to cost curves derived from the time dimensions provide a source of difficulty because of the nature of the cost curves. Cost curves of this type are characterized in the section of this report dealing with the high capacity gin models. In these models, plants were assumed to operate at a constant rate of efficiency and only time was varied.

above exceptions are seldom important enough to cause the total cost curve to lose its linear shape. Variations in total volume would come almost entirely from variation in total hours of operation per year. Cost and volume, both being linear function of time (hours), are also linear functions of each other.

The time dimension is extremely important in considering certain agricultural products. Production in agriculture is unlike production in industry in that industrial products can be produced year around to meet demand. Agricultural products are produced seasonally and must be processed and/or stored to meet year around demand. In this respect "time"—that period of the year in which the agricultural product is harvested—becomes in effect an input in determining total output. Therefore, an increase in time as an input could be just as important in reducing per unit cost as any other cost reducing input. Additional "time" can be provided by lengthening the harvest season or holding the product after harvest to delay processing and allow plant operation for a longer time period each year. The latter alternative will be developed for the cotton ginning industry.

The cotton ginning industry in the Delta is characterized by a relatively large investment in machinery and equipment, short operating seasons, and low annual volumes of output; each of which contributes to a relatively high per unit cost of operation. Because of the relatively high fixed cost in relation to variable costs, additional units of output bring greater cost reduction in the early stages than they do in later stages of expanding plant output. In other words, "proportional returns to scale" are extremely high in the early stages of plant output. The changing ratio of the fixed, compared with the variable costs, results in a rapidly decreasing average cost curve over the first segment of the curve. This rapidly decreasing average cost curve exists for approximately the first one-third of the estimated annual volume of the plant regardless of plant scale.[3] Thus, for any size of plant, proportional returns to scale are greatest if the plant can be operated at capacity for a period of approximately four months. Most gins in the Delta are operating at capacity during a six to eight week period. This period corresponds to the harvest season. To lengthen the ginning season to a four-month period would result in a substantial decrease in average costs per bale resulting from spreading the relatively high fixed costs over a larger volume. Extending the ginning season would necessitate delayed ginning which would be possible with seed cotton storage.

Seed cotton storage would result in additional costs, both fixed and variable. The extent to which storage would be practicable would depend on the relationships or degree of quality deterioration, the added costs of storage, and the decreased costs of ginning. The determination of the occurrence and/or extent of

[3]Annual volume refers to the number of bales of cotton which could be processed in a year on a given size plant operated at hourly capacity for ten hours per day, six days per week for the entire year. In fact, annual volume defined in this manner provides a constant average variable cost curve, which results in a decreasing average cost curve throughout the volume range under consideration.

quality deteriorations in cotton lint or seed is paramount to the problems of costs and must preceed any other study to determine the economic extent to which delayed ginning is profiable.

Limitations

The major limitation of the data as presented in this report is that it lacks a common thread of uniformity. Each segment, because of assumptions and characteristics provided by different locations in the Mississippi Delta, must be dealt with individually. This does not preclude the possibility of one combining the results into some meaningful summary statements, but it does preclude any definite specific cost comparisons being made.

Certain limitations will also be pointed out as the data are presented for the specific sections.

TRANSPORTATION AND DENSITY OF PRODUCTION[1]

The fact that lower per bale ginning costs are associated with increased volumes of cotton ginned is well documented in the literature concerning cotton gins.[5] The achievement of these economies is dependent upon the availability of sufficient cotton in the vicinity of the gin. This study will be concerned primarily with examining those problems of combining assembly costs of cotton with costs within the gin to achieve least-cost combinations.

The problems of cotton ginners are somewhat different from those of processors ordinarily considered in the literature. Most studies heretofore have dealt with assembly costs and in-plant economies of scale for processing operations where the processor has taken title to the commodity, usually at the farm. As a result, they have encompassed the total cost structure, including both assembly and processing costs.

Cotton ginners, on the other hand, ordinarily perform a service for the producer which makes his product suitable to enter existing marketing channels. As a rule, the ginner receives a fee for performing the ginning service and does not take title to the cotton. As a result, ginners seldom consider the total cost picture of assembly and ginning, although recent moves by ginners to provide trailers for use by customers have made them more cognizant of assembly costs than before. Exceptions do exist where the ginner buys cotton from the producer for later sale.

Although assembly costs are usually borne by the producer and are a matter of indifference to the ginner, this study is concerned with the cost to the industry as a guide to over-all industry objectives.

Decreasing gin numbers and increasing gin capacities indicate a transition in the Delta from small, simple gins to large, high-speed, elaborately equipped gins. Assuming the continuation of this trend, a long-run economic guide should be helpful to ginners in determining where to locate cotton gins and how large to build them for maximum efficiency.

The specific objectives of this phase of the study are as follows:

1. To devolop estimates of seed cotton assembly costs for the most prevalent method of moving seed cotton in the delta.
2. To evaluate the influence of cotton production density, assembly costs, length of ginning season, and seed cotton storage on optimum size and location of cotton gins.

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[1] Condensed from bulletin by C. D. Covey and James F. Hudson, *Cotton Gin Efficiency*, Louisiana Agricultural Experiment Station Bulletin 577, Department of Agricultural Economics and Agribusiness, Louisiana State University, Baton Rouge, Louisiana, December, 1963. Data presented in this section have particular application to Louisiana and may need refinements for other states.

[5] For a relatively complete listing of these studies, see C. D. Covey, "Cotton Gin Efficiency as Related to Size, Location and Cotton Production Density in Louisiana" (Unpublished Ph.D. dissertation, Department of Agricultural Economics and Agribusiness, Louisiana State University, 1963.)

LIMITATIONS OF STUDY

To those who might use the results of this study without a full appreciation of the methodology used, a word of caution seems appropriate. The fixed cost allocations and some of the assumptions used in the study were necessarily based on judgment. However, the cost estimates used are considered to be typical and reasonable for the situation in which they occur. When an assumption was made which required a considerable amount of judgment, because of a lack of information, or because of wide divergences in available information, a special effort was made to clarify the decision in detail in order that the reader might reach his own conclusions concerning its validity.

A further limitation of the study involves the distribution of seed cotton receipts at gins. The distribution used was a 10-year average and therefore concealed the wide differences in harvesting patterns which occur from year to year. This distribution was basic to the determination of annual gin capacities and to the costs involved in the storage of seed cotton. To the extent that year to year changes in the distribution of seed cotton arrivals differ from the average distribution used, annual gin capacities and the amount of seed cotton requiring storage will depart from those used in this study.

ASSEMBLY COSTS OF SEED COTTON

Most early studies of cotton ginning costs considered only the costs within the gin itself. Almost without exception their conclusion was that the key to more efficient ginning and lower costs was added volume. The relatively high fixed costs per unit of output, coupled with the constant speed characteristic of cotton gins, account in large measure for this conclusion.

The conclusion that volume is the key to increased efficiency and lower ginning costs appears correct but the earlier studies go no further than the recommendation that gins increase their volume. The added costs of assembling this volume have been vaguely alluded to in only one or two studies.

Additional cotton can be obtained at the gin by increasing the intensity of production in the existing supply area, extending the supply area, or a combination of both. In either event, added costs are incurred to obtain additional volume. More intense production within the existing supply area will bid up the price of certain input factors, while extending the supply area will increase per unit costs of assembly.

Because of the acreage controls now imposed on cotton production, the alternative of more intense production in the existing supply area is of limited use. It is possible, of course, with the adoption of presently known technology to increase production in a given plot or allotment by a substantial amount, but innovations and new techniques are ordinarily adopted by producers in a rather well defined pattern. That is, the number of farmers adopting a particular new practice over time will closely approach a normal or "bell-shaped" distribution.[6]

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[6]Everett M. Rogers, "Categorizing the Adopters of Agricultural Practices," *Rural Sociology*, XXIII, 1958, pp. 345-354.

For this reason, it does not appear reasonable to assume that there will be an appreciable acceleration in the adoption of new cotton production technology; consequently, the alternative of more intense production in the supply area is of limited usefulness.

In light of the limitations placed on production by the acreage control program and the current surplus position of cotton, the alternative of extending the supply area appears to be the most fruitful approach to increased volumes at cotton gins.

Any manageable approach to the determination of seed cotton assembly costs must of necessity involve a number of simplifying assumptions. The principal assumption made in this analysis is that all facilities necessary to move seed cotton to gins already exist and are sufficient to handle the applicable volumes of cotton. Within some, as yet undefined, distance from the gin this assumption conforms to actual conditions. However, at some point, when time consumed in hauling from more distant points makes it necessary to invest in additional hauling equipment, this assumption becomes less realistic.

Within the framework of the existing gin complex this assumption would break down quicker than in a situation where some type of seed cotton storage was available at cotton gins. Storage facilities would permit farmers to unload their trailers upon arrival at the gin and return almost immediately to the field, thereby obtaining a more efficient utilization of trailers. The limiting factor under existing conditions is the time which is utilized by the loading trailer sitting on the gin yard waiting to be emptied. When compared with waiting periods at the gin of 12, 24 and even 36 hours, the actual road time for trailers is relatively insignificant even from the more distant points of production. For example, ginners in the Delta indicate that relatively little cotton is hauled more than 10 miles to be ginned. At 25 miles per hour this is approximately 48 minutes road time, both ways.

Method of Assembly

In the Delta, cotton is brought to the gin in almost any conceivable type of vehicle, from a mule and wagon hauling one bale to large four-wheel trailers hauling 10 or more bales. Five-bale, four-wheel trailers are quite common and are the usual size supplied to farmers by cotton gins. Use of a pickup truck to pull trailers allows the farmer to leave a loaded trailer at the gin and immediately return to the field with an empty one.

Ordinarily, one pickup truck will serve as the motive power for a number of cotton trailers. The exact ratio of pickup trucks to trailers would depend on a host of factors, including such things as number of trailers owned, number of pickers operated, distance from the gin, and size of the trailers. The ratio of trucks to trailers is given consideration in the cost estimates by spreading fixed costs over considerably more miles of travel for the truck than for the trailers during harvesting season. A pickup truck in used for numerous jobs associated with harvesting other than pulling seed cotton trailers. Actual road time pulling trailers to and from the gin appears to be quite small relative to the amount of time spent at the field performing service tasks. Ordinarily the truck is tied up at the gin only long enough for the driver to unhook, locate an empty trailer, and hook onto it.

Estimates of costs associated with the use of pickup trucks and cotton trailers used to haul cotton from the field to the gin were obtained from several sources. Data on truck prices, average years of use, and average trade-in values were obtained from several truck dealers. Cotton trailer prices and estimates of useful life were obtained from a small, judgment sample of cotton producers and custom cotton harvesters.

Truck Costs

The harvesting and hauling of seed cotton is a seasonal operation, with producers using their pickup trucks for other enterprises throughout the remainder of the year. Fixed costs associated with the truck must be allocated between these various enterprises. The general consensus among the producers interviewed was that about one-third of the truck costs should be allocated to seed cotton harvesting and hauling.

Fixed Costs

Prices of pickup trucks ranged from $1,600 to $2,800. In addition, there was a wide divergence of opinion as to the size of pickup most suited to cotton hauling. Some producers found ½-ton trucks adequate, while others considered ¾-ton trucks best. In operations where the truck was used to pull loaded trailers out of the field, ¾-ton trucks were found most satisfactory. Other producers kept a tractor in the field to pull trailers out to the road, In this case, ½-ton trucks were considered adequate. The average replacement cost of all estimates was $2,200. This figure was used in computing interest and depreciation costs.

In estimating per mile truck costs of hauling seed cotton an assumption concerning the annual truck mileage was necessary. Based on the limited information available it was assumed that the truck was driven 12,000 miles each year. Per mile fixed costs were determined by dividing the total costs by the total miles driven each year.

Fixed costs associated with the use of a pickup truck included depreciation, interest on investment, insurance, taxes, and inspection fees (Table I).

Variable Costs

The variable costs or operating costs per mile include such cost items as fuel, oil and filters, lubrication, tires and repairs and maintenance (Table II).

Labor: Producers generally agreed that road speeds in excess of 25 miles per hour with a loaded cotton trailer were not practical. Beyond this speed cotton begins to blow off the load if it isn't covered. Most producers do not cover

TABLE I — ESTIMATED ANNUAL FIXED COSTS OF OPERATING 1/2-3/4 TON PICKUP TRUCKS

Item	Average Annual Fixed Cost
	Dollars
Depreciation:	
Straight line, 5 years, with $500 trade-in allowance	340.00
Insurance:	
(a) Public liability ($10,000 - $20,000)	28.60
(b) Property damage ($5,000)	13.00
(c) Comprehensive (Fire, theft, and windstorm)	19.40
(d) Collision ($100 deductible)	87.40
Interest on Investment:	66.00
State license tags:	3.00
Annual state vehicle inspection	2.00
Total annual fixed costs	559.40
Per mile fixed costs	0.047

TABLE II — ESTIMATED VARIABLE COSTS OF OPERATING 1/2-3/4 TON PICKUP TRUCKS

Item	Average Cost per Mile
	Dollars
Gasoline (10 M.P.G. @ 30¢ per gallon)	0.030
Oil (6 qts per 1,000 miles @ 40¢ per qt.)	0.002
Filter (1 per 1,000 miles @$2.00)	0.002
Lubrication (every 1,000 miles @ $1.50 ea.)	0.001
Tires ($125.00 per set of 4, 18,000 miles per set)	0.007
Repairs and maintenance ($64.89 per year, 12,000 miles per year)	0.005
Total variable cost per mile	0.047

TABLE III — ESTIMATED FIXED AND VARIABLE LABOR COSTS FOR HAULING SEED COTTON BY PICKUP TRUCK AND FOUR-WHEEL TRAILER

Item	Cost
	Dollars
Variable Labor Costs:	
Time on road (25 M.P.H. @ $1.00 per hour)	0.04 per mi.
Fixed Labor Costs:	
Time in field (2 hours @ $1.00 per hour)	2.00 per trip
Time at gin (20 minutes @ $1.00 per hour)	0.33 per trip
Total fixed labor costs per trip	2.33

cotton trailers while they are in transit. Therefore, labor costs for road time were figured at 25 miles per hour both ways.

Ordinarily the owner drove the truck in hauling cotton to the gin. Most producers, however, felt that suitable labor could be obtained to perform this function for $1 per hour.

The time per trip, or the time per 5 bales hauled (assuming a 5-bale-size trailer), is made up of an independent fixed part and a variable part which is a function of distance. The fixed labor cost per trip is dependent upon the time spent at the field end of the trip and the time spent at the gin. Estimates of the time spent at the gin indicated considerable uniformity and averaged about 20 minutes per trip.

Reliable estimates of the time spent at the field end of the trip were extremely difficult to obtain. The primary reason for this was the fact that owners were serving as truck drivers and managers at the same time. Consequently, the driver might be called upon to perform any number of different tasks in the field, from tramping cotton to repairing or greasing the cotton picker. In light of the limited information available a somewhat arbitrary estimate of 2 hours was used. Estimates of both fixed and variable labor costs associated with the assembly of cotton are shown in Table III.

Trailer Costs

Investment and operating cost estimates were obtained on four-wheel, steel cotton trailers with a capacity of approximately 5 bales of spindle-picked cotton.

Fixed Costs

Fixed costs for cotton trailers include only two items, depreciation and interest on investment. No costs were included for insurance, license tags, or state vehicle inspection. Most truck liability and property damage insurance coverage also includes the trailer. No license tags or inspection fees are required on farm trailers in some states and can be readily added for others.

Depreciation: Estimates of the usable life of a steel cotton trailer ranged from 10 to 15 years. In using a 12-year depreciation period and not including a cost for shelter, it was necessary to include the cost of painting the trailer every three years. Essentially, the cost of preserving the trailer from weather damage is included as a variable rather than a fixed cost.

Interest on Investment: The average annual interest on investment costs for trailers was computed in the same manner as for trucks; the replacement value was divided by two and multiplied by the current rate of interest.

Variable Costs

Although a distinction has been made between fixed and variable costs associated with the use of cotton trailers, the distinction is not clear. It could be argued that all costs are fixed in nature. Tires, for example, deteriorate whether the trailer is used or not. Since the actual number of miles used per season is very low, the only added hazard incurred by using the trailer is from punctures and blowouts.

Time spent on the road is a very small portion of the useful life of a cotton trailer. Most of the time it sits empty in the field, or at the gin, either loaded or unloaded. Distances between the field and the gin seldom exceed 10 or 12 miles. In determining costs per mile it was assumed that trailers traveled 250 miles per season. Fixed and variable trailer costs are shown in Table IV.

TABLE IV – ESTIMATED ANNUAL FIXED AND VARIABLE COST OF OPERATING A FIVE-BALE STEEL COTTON TRAILER

Item	Cost	
	Dollars	
Fixed Costs:		
Depreciation (straight line, 12 years with no salvage value)	57.17	per year
Interest on investment	20.58	per year
Per mile fixed costs	0.311	
Variable Costs:		
Tires (one tire per year @ $27.00)	0.108	per mile
Repairs, paint, and grease ($13.00 per year)	0.052	per mile
Total variable costs per mile	0.160	

Assembly Cost Relationships

The previous section was devoted to examining the nature of costs necessary to assemble seed cotton at the gin. Certain assumptions were made to facilitate the computation of per mile costs of assembly. Fixed labor costs were 46.6¢ per bale, while variable costs per bale mile were 24.2¢.

The density of cotton over a specified area of production may vary widely as the distance from the gin increases. However, in order to facilitate analysis it was assumed that production density was constant over the area at some average level. This is the only practical approach to problems of estimating assembly cost functions.

Table V shows the amount of cotton available to a gin for a side range of field-to-plant travel distances for four levels of production density per square mile. For small volumes, the difference in travel distance for relatively low production density and high production density is quite small. However, for large volumes the difference in travel distance is quite large.

The relation between volume of cotton and the average per bale cost of assembly for four levels of cotton production density is shown in Table V and Figure 1.[7]

[7]Considerable variation occurs in the per bale cost of assembling cotton as presened herein and as presented in a recent bulletin published by the Tennessee Agricultural Experiment Station. Tennessee Station Bulletin No. 366 provides assembling costs which differ from those presented in this report primarily due to a) miles traveled per trailer per season, b) variation in time in the field which affects the number of trips per day, and c) use of one versus two five-bale trailers. More detailed information on these alternatives is provided in the Tennessee bulletin.

TABLE V — FIELD-TO-GIN TRAVEL DISTANCES AND AVERAGE COST PER BALE FOR SPECIFIED VOLUMES OF COTTON AND FOUR LEVELS OF PRODUCTION DENSITY

Volume	Production Density per Square Mile: 50 bales		100 bales		200 bales		300 bales	
	Distance	Avg. Cost	Distance	Avg. Cost	Distance	Avg. Cost	Distance	Avg. Cost
Bales	Miles	Dollars	Miles	Dollars	Miles	Dollars	Miles	Dollars
1,000	2.52	.77	1.78	.68	1.26	.62	1.03	.59
2,000	3.56	1.20	2.52	.99	1.78	.83	1.45	.77
3,000	4.37	1.42	3.09	1.14	2.18	.94	1.78	.86
4,000	5.04	1.60	3.56	1.27	2.52	1.04	2.06	.93
5,000	5.64	1.76	3.98	1.38	2.82	1.11	2.30	.99
6,000	6.18	1.90	4.37	1.48	3.09	1.18	2.52	1.05
7,000	6.67	2.02	4.72	1.56	3.33	1.24	2.78	1.10
8,000	7.13	2.14	5.04	1.65	3.56	1.30	2.91	1.15
9,000	7.56	2.24	5.35	1.72	3.78	1.35	3.09	1.19
10,000	7.97	2.34	5.64	1.80	3.98	1.40	3.25	1.23
11,000	8.36	2.44	5.91	1.86	4.18	1.45	3.41	1.27
12,000	8.74	2.54	6.18	1.93	4.37	1.50	3.56	1.31
13,000	9.09	2.62	6.43	1.99	4.54	1.54	3.71	1.35
14,000	9.44	2.71	6.67	2.05	4.72	1.59	3.85	1.38
15,000	9.77	2.79	6.91	2.11	4.88	1.63	3.98	1.42
16,000	10.09	2.87	7.13	2.16	5.04	1.67	4.12	1.45
17,000	10.40	2.94	7.35	2.22	5.20	1.70	4.24	1.48
18,000	10.70	3.02	7.56	2.27	5.35	1.74	4.37	1.51
19,000	11.00	3.09	7.77	2.32	5.49	1.78	4.48	1.54
20,000	11.28	3.16	7.97	2.37	5.64	1.81	4.60	1.56
21,000	11.56	3.23	8.17	2.42	5.78	1.85	4.72	1.59
22,000	11.83	3.30	8.36	2.46	5.91	1.88	4.83	1.62
23,000	12.09	3.36	8.55	2.51	6.05	1.91	4.93	1.65
24,000	12.36	3.42	8.74	2.56	6.18	1.95	5.04	1.67
25,000	12.61	3.49	8.92	2.60	6.30	1.98	5.15	1.70
26,000	12.86	3.55	9.09	2.64	6.43	2.00	5.25	1.72
27,000	13.11	3.61	9.37	2.69	6.55	2.04	5.35	1.75
28,000	13.34	3.66	9.44	2.73	6.67	2.07	5.45	1.77
29,000	13.58	3.72	9.60	2.77	6.79	2.10	5.54	1.80
30,000	13.82	3.78	9.77	2.81	6.90	2.12	5.64	1.82

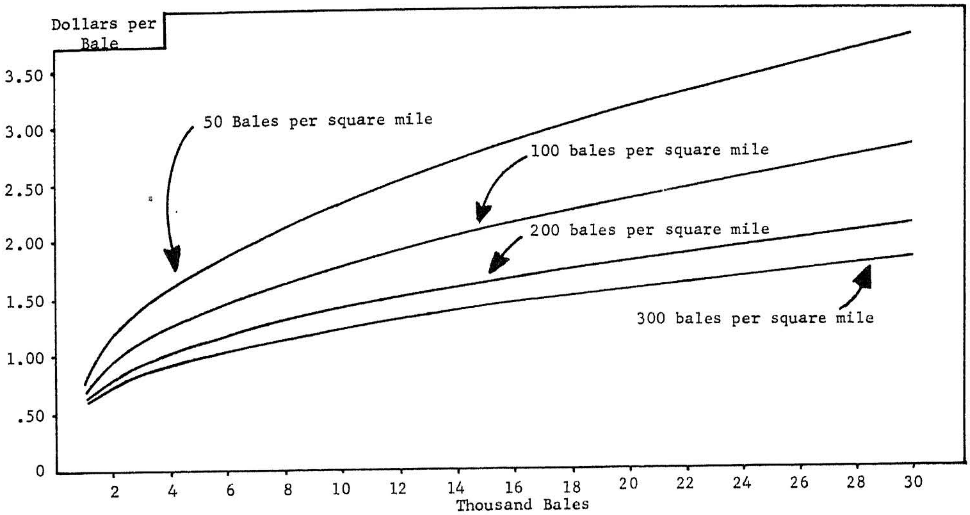

Fig. 1 — Relation of Average Assembly Cost to Volume of Cotton Supplied to Gin for Four Levels of Production Density, Louisiana, 1961-62.

Density has only a small influence on assembly costs at low volumes. At the relatively low volume of 1,000 bales, assembly costs per bale vary from 77¢ to 59¢. At the relatively large volume of 30,000 bales these costs range from $1.82 to $3.78 per bale.

Determination of assembly cost estimates was but the first step in developing optimum or least-cost combinations of ginning and assembling seed cotton. The analysis must now proceed to estimates of per bale seed cotton storage and ginning costs for various gin sizes and annual volumes. Following this, the task is one of simply adding the two cost functions together.

SEED COTTON STORAGE AS A METHOD OF INCREASING ANNUAL VOLUME[8]

Scientists have been concerned for some time about the effects of storage on cotton lint. The results of earlier research are not conclusive and in many cases not complete. The present economic situation of the cotton gin owners has caused renewed interest in seed cotton storage. Associated problems are important as a consequence or result of the major problem. These associated problems include the effects of storage on the quality of the seed and spinning value compared to market value of the lint. These subsequent problems raise the question at to whether or not lint quality is adequately reflected in price and/or performance in the mill. Questions are also raised as to the economic feasibility of storing seed cotton in different types of facilities as well as in different locations.

The charges for ginning cotton in the Delta vary greatly from state to state and average about one-tenth the value of the lint bale. The most promising possibility for lowering these ginning charges would seem to be through lower costs of ginning. One means of reducing the costs of ginning cotton would be to increase the annual volumes of ginning. With present methods of harvesting this would mean that the ginning season would have to be extended beyond the harvest season. Storing seed cotton on a long term basis would make this extension possible.

OBJECTIVES

The research reported here was guided by the following objectives:

1. To determine the effects of prolonged storage of seed cotton prior to ginning on the grade and staple length measurements of cotton;
2. To determine the effects of prolonged storage of seed cotton prior to ginning on the measurable fiber quality characteristics of the fiber;
3. To determine the effects, if any, of prolonged seed cotton storage prior to ginning on mill performance and spinability;
4. To determine the effects on the cash price of cotton due to storage over prolonged periods of time;
5. To determine the effects of different types of storage facilities on the various quality measures of cotton with respect to length of storage period;
6. To determine the relative costs of different types of storage facilities.

All cotton was harvested by spindle pickers, and sample lots were selected from those picked during that portion of the day recommended "safe" from the standpoint of moisture by the Cooperative Extension Service personnel.

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[8]Material for this section taken from V. Alonzo Metcalf, "An Analysis of An Alternative Marketing System for Cotton Involving Delayed Ginning Through Various Storage Techniques." Ph.D. *Thesis*, University of Missouri.

Immediately after the cotton was emptied from the picker into the trailer for transport to the storage facility, a sample was removed. The sample was collected by manually pulling handfuls from the load, special care being taken to obtain a representative sample by selecting cotton from different locations and depths.

Three types of storage were tested in 1961, cotton houses, open trailers, and metal trailers. The cotton houses were the conventional round type houses constructed of wood and corregated steel that have been used for several years for short time storage of hand-picked cotton in connection with the ginning process. The open trailers were of standard kind and five-bale size as used in transporting cotton from the field to the gin. They were approximately seven feet by 18 feet by five feet high with wire mesh sides supported by wood or steel stakes, and there was no top or cover. The metal trailers differed in that they were six feet by 12 feet by five feet high and had solid steel sides and floor. Additional types of storage facilities were utilized in 1962. These included an open basket, wire bin, hay press, and partitioned trailer. The basket was eight feet by 24 feet by eight feet high with wire mesh sides supported by steel stakes. A wire bin was constructed ten feet by 20 feet by eight feet high with a double wire partition dividing it into two separate containers. A roof was included on the bin but no ground covering was used.

The cotton that was pressed in a hay baler was stored inside a building with concrete floor. Trailers with open mesh sides were also partitioned lengthwise of the trailer. The partitions were double partitions of open wire mesh with four inches of air space between the two partitions to allow air circulation near the center of the mass of seed cotton. All trailers and baskets used during both years were stored under pole-type sheds with ample roof covering but no side walls.

After being ginned, the lint from the seed cotton sample was considered to be uniform throughout and was divided into portions. To meet the objectives of the study, determinations were needed on the grade, staple length, fiber fineness, fiber strength, fiber elongation, fiber color, upper half mean length, mean length, uniformity ratio, and trash content.

The laboratory spinning tests provided indications of the yarn appearance, nep count of the card web, yarn strength and the manufacturing waste of the cotton lint.

After 30 days of storage the sampling process was repeated. The method used was to compare the results from the tests made after storage with the results from the tests made before storage began. The sampling and distributing process was repeated each 30 days until the cotton had been in storage for a period of four months.

After the cotton was ginned, the cotton representative bales were chosen to be processed in a commercial mill. The stored cotton was spun and the results were compared with the results from bales spun without being stored. The control bales of cotton were of the same variety, grown in the same field and picked at approximately the same time as cotton with which they were compared. The factors determined at the mill were yarn strength, yarn appearance and estimates of mill efficiencies.

The cotton stored during the second year in the large basket-type container was loaded into the basket by air conveyance, and, therefore, some drying effect occurred. The moisture content of this cotton was lowered two percent by this conveyance process. In the process of conveying the cotton from the trailer to the large storage basket, the cotton was also put through a stick and bur machine. All other cottons were stored exactly as they came from the field, with the cotton that was stored in cotton houses being conveyed from the trailer to the cotton houses by air. The cotton stored in open wire bins was put into the bin by hand operations since no air conveyance equipment was available.

"Seed sample portions" were collected at each sampling during 1962. The seed sample portions were submitted for analysis to ascertain any changes which might occur during storage. The seed sample portions were tested for germination, total foreign matter, moisture, free fatty acids in oil, oil, ammonia and lint. The results from these tests were converted to units and used to calculate the net quality index, the quantity index and the grade of the seeds.

The spinning tests made at the commercial mill for 1962 were much more complete than those for 1961. The cotton yarn was tested for strength, appearance, and evenness. In addition, determinations were made in spinning on ends-down, other stoppage, and neps in card web.

The data from the tests were tabulated for individual samples and observed. There were no differences in the findings to indicate that there were differences by type of storage. Therefore, the analyses were completed on the total observations.

EFFECTS OF STORAGE PRIOR TO GINNING ON FIBER QUALITY

The types of storage varied between years. During the first year of the study the only methods used were open trailer-pole-type shed, the metal trailer, and cotton houses (Figure 2). However, the second year the large basket type storage and the open wire-bin type storage were also used. While each type of storage showed some variation in ranking of individual lots of cotton for various measures of fiber property, no consistent variations prevailed. Only those fiber properties which varied significantly are discussed.

Occasionally, erratic and unexplainable variations occurred by storage periods for individual fiber quality measurements on individual samples. These were, in most cases, not related to any relevant consideration and in all cases were double checked. Some resulted from errors and incorrect recording of test results.

This portion of the report will be confined to discussion of average measures of each item by length of storage period.

Fig. 2 — Types of Storage Facilities Utilized in Storing Cotton Prior to Ginning, Missouri, 1961-62

Staple Length

The classer's call of staple length varied by length of storage. In 1961 the variations in staple length were statistically significant at the 5 percent level; for 1962, the significance was at the 1 percent level.

Variations in staple length for the year 1961 were not great enough to cause the average staple length to be placed in any group except 1 3/32 inches (Figure 3). However, for 1962, the average staple length decreased for the first 60 days and decreased sufficiently for the cotton to be changed from the 1 1/16 inches to the 1 1/32 inch call after 60 days. After 120 days of storage, the classer's call was back to the pre-storage level of 1 1/16 inches.

Fiber Strength

The Pressley Fiber Strength Tester was used in this study to determine fiber strength.

The average fiber strength, expressed as thousand pounds per square inch, varied from 81.5 at storage to 82.0 for the 30 to 60 day storage periods (Figure 4). Fiber strength was 81.0 after 120 days of storage. For the 1961 crop the vari-

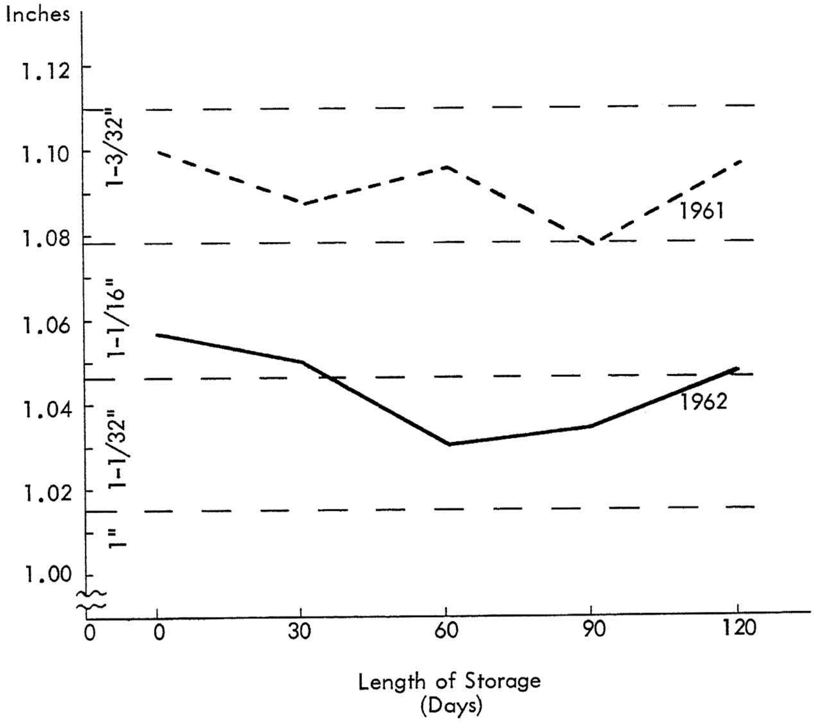

Fig. 3 — The Effects of Storage on the Staple Length of Cotton by Length of Storage Period, Missouri, 1961-62.

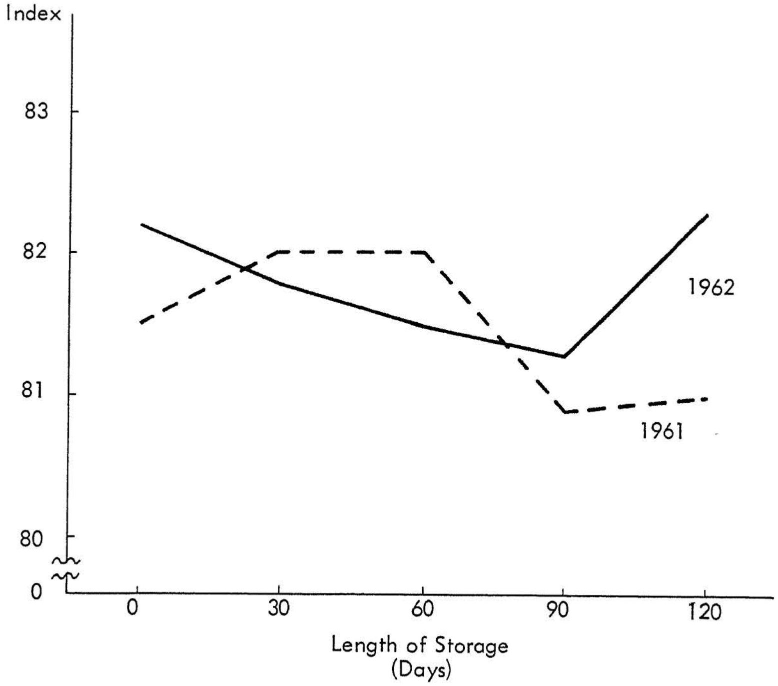

Fig. 4 — The Effects of Storage on the Strength of Cotton by Length of Storage Period as measured by the Pressley Fiber Strength Tester, Missouri, 1961-62.

ations in fiber strength by storage periods were small, statistically insignificant and not great enough to move the fiber from one grouping to another.

For the year 1962, the average fiber strength, (000 psi), varied from 82.2 at the time of entering storage to 82.3 after 120 days of storage. The low of 81.3 was recorded after 90 days of storage. The variations in fiber strength for the 1962 crop by storage periods were statistically significant but not great enough to move the cotton strength index from one classification to another.

UNIFORMITY RATIO, UPPER HALF MEAN LENGTH, AND MEAN LENGTH

The Fibrograph instrument was used to measure both upper half and mean length in inches and hundredths of an inch. The uniformity ratio is the mean length divided by the upper half mean.

The uniformity ratio variations by length of storage period were statistically significant for both years. For the 1961 cotton the variations were significant at the five percent level and in 1962 the significance was at the one percent level.

The uniformity ratio of the cotton when stored in 1961 was 77.0 and was 76.8 after 120 days of storage (Figure 5). During the storage period, the uni-

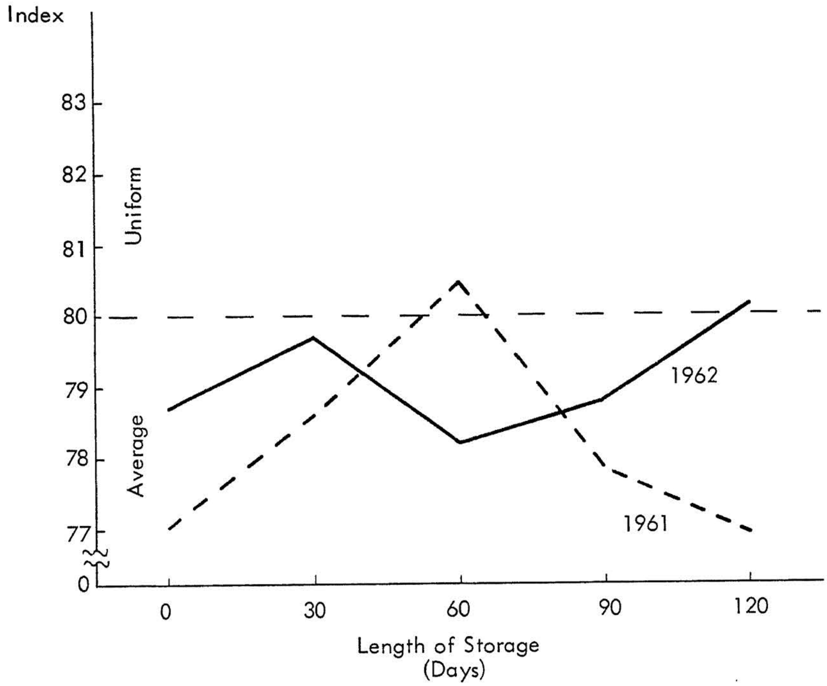

Fig. 5 — The Effects of Storage on the Uniformity of Ratio of Cotton Fibers by Length of Storage Period, Missouri, 1961-62.

formity ratio increased to a high after 60 days of storage. The uniformity ratio after 60 days of storage was sufficiently high to cause the lint to be grouped in a higher grouping than before storage. In 1961, the uniformity ratio increased for the first 60 days of storage then decreased for the next 60 days to the level at storage time.

During 1962, uniformity ratio increased from 78.7 at storage to 81.3 after 120 days of storage. The variations in uniformity ratio were such that the index indicated that the cotton lint was more uniform when taken out of storage than when it entered storage 120 days earlier.

Upper Half Mean Length

Upper half mean length, the measure most closely approximating the classer's staple length, was determined for all samples in 1961. Spot checks indicated after the first tests were completed that the results of the two determinations were not comparable. Therefore, all samples were submitted for duplicate determinations of upper half mean length. The upper half mean length determinations at the time the other tests were made varied significantly throughout the storage period. The duplicate determinations made approximately ten days later did not vary significantly. Variations that were significant are discussed. The

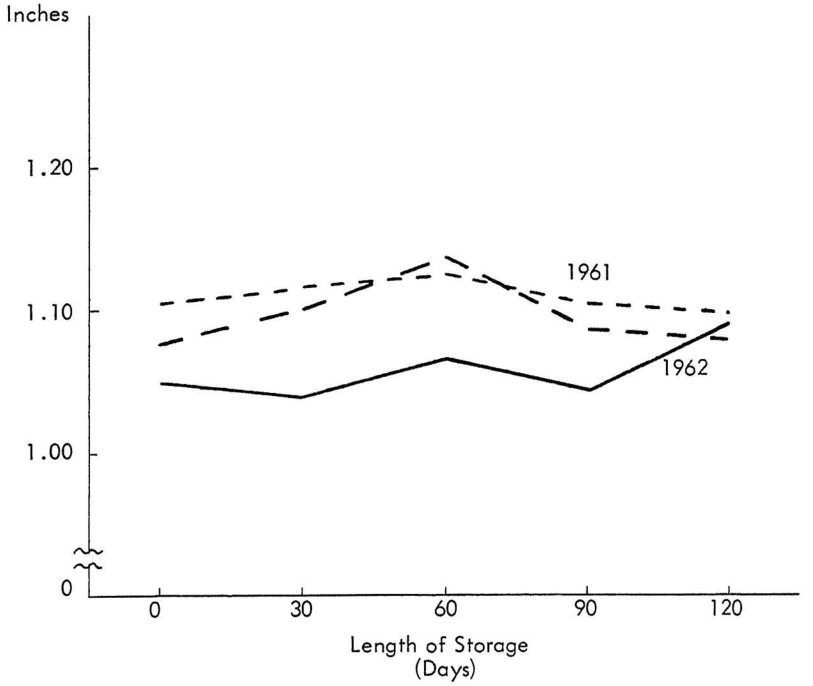

Fig. 6 — The Effects of Storage on the Upper Half Mean Length of Cotton Fibers by Length of Storage Period, Missouri, 1961-62.

upper half mean length at the time of storage was 107.9 and was 108.0 after 120 days (Figure 6). During the storage period upper half mean readings were higher than at storage or after 120 days. The upper half mean length increased from the 1 3/32 inch grouping to the 1 1/8 inch grouping after 30 and 60 days of storage. After 90 days and 120 days of storage, the upper half mean had decreased to its original level or slightly below.

For 1962, the upper half mean length was 105.1 at storage and 109.0 after 120 days of storage. During the storage period the upper half mean reading varied slightly above and below the level at harvest time The variations were significant at the 5 percent level. After the first storage period, the upper half mean had decreased from the 1 1/16 inch to the 1 1/32 inch group, then regained length to the 1 1/16 inch group after 90 days, but lost back to the 1 1/32 inch group after 90 days, then increased to the 1 3/32 inch group after 120 days.

Mean Length

Mean length varied significantly for the 1961 crop but the variations were insignificant for 1962. Mean length varied exactly as the uniformity radio did

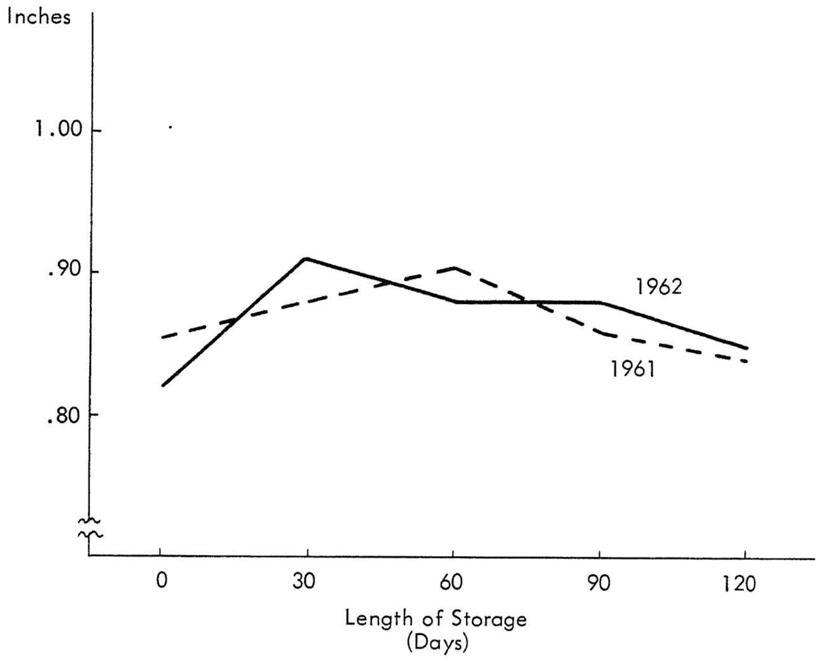

Fig. 7 — The Effects of Storage on the Mean Length of Cotton Fibers by Length of Storage Period, Missouri, 1961-62.

during 1961 (Figure 7). During 1962, mean length varied as uniformity ratio did for the first 60 days, then inversely for the last two storage periods.

Nonlint Content

The nonlint content, or foreign matter content, is expressed as a percent of the weight of the untreated sample. The Fractionator provides a means for determining foreign material content in seed cotton. Certain data from the fractionator test were not usable in the analysis as the components of total trash were measured in different categories for portions of the tests. The net results of the fractionator tests correlated very closely with the results of the Shirley Analyzer.

The components of total waste removed by the fractionator and designated as large and small trash are significant in their relation to length of storage.

While the percent of visible waste and total waste as measured by the Shirley Analyzer varied, the variations were not statistically significant. Visible waste increased slightly for both years for the first storage period. (Figure 8)

During the second 30 days of storage visible waste increased rapidly, then fell during the next 30 days and remained about constant for the last storage period.

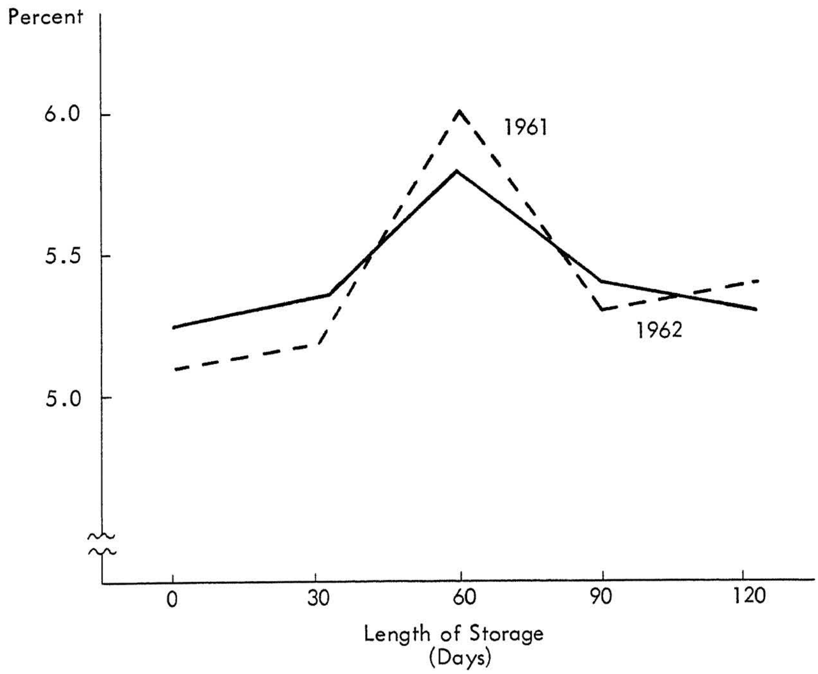

Fig. 8 — The Effects of Storage on the Visible Waste in Cotton Lint by Length of Storage Period, Missouri, 1961-62

Total waste varied slightly but consistent patterns were not visible (Figure 9).

The changes in the level of large and small trash content, as measured by the Fractionator instrument, were significant for the 1961 and 1962 years. For 1961, the large trash content decreased from 0.92 percent at storage to 0.02 percent after 60 days of storage (Figure 10). The large trash content then increased to 0.44 percent after 90 days of storage and 0.45 percent after 120 days of storage. During the first 30 day storage period, small trash content increased from 0.95 to 1.04 percent, then decreased to 0.86 percent after 60 days of storage, 0.35 percent after 90 days and 0.31 percent after 120 days of storage (Figure 11).

For 1962, the large trash content increased from 0.65 to 0.96 percent after 60 days of storage. Large trash content then decreased to 0.91 percent after 90 days, and 0.81 percent after 120 days of storage. Small trash content increased from 0.90 percent at storage to 1.80 percent after 60 days, then decreased to 1.49 percent after 90 days. After 120 days of storage the small trash content was 1.72 percent in 1962.

Ordinarily it would be expected that if total waste content remained constant, then as large trash decreased, small trash would increase, but this was not

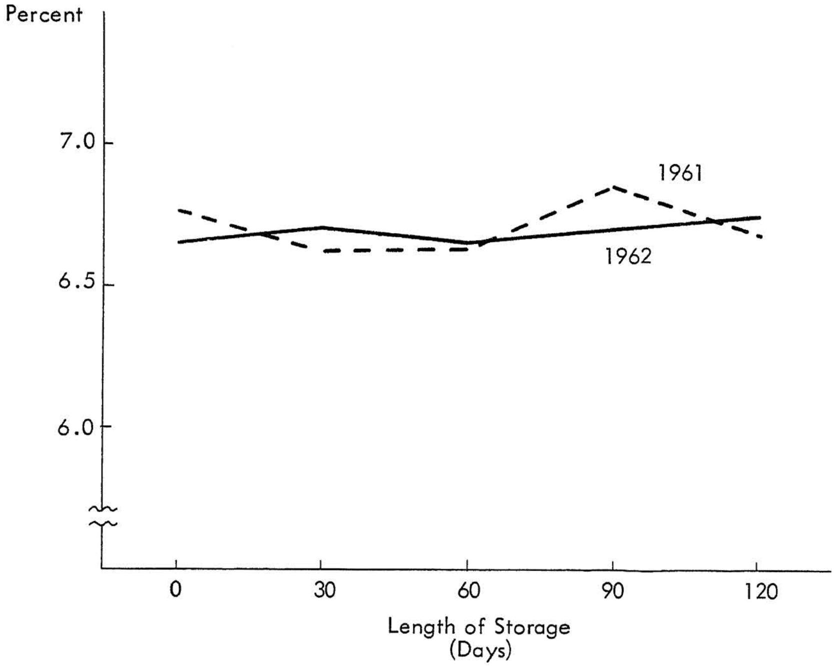

Fig. 9 — The Effects of Storage on the Total Waste in Cotton Lint by Length of Storage Period, Missouri, 1961-62.

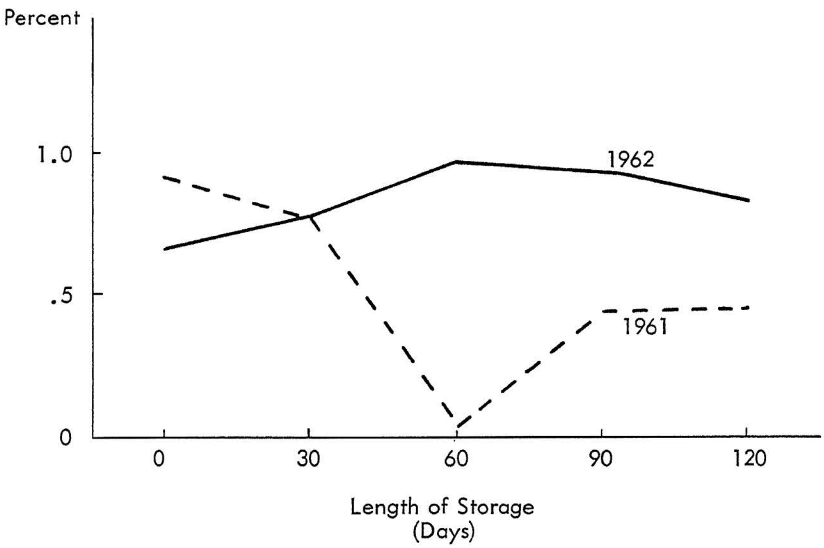

Fig. 10 — The Effects of Storage on the Large Trash Content of Cotton Lint by Length of Storage Period, Missouri 1961-62.

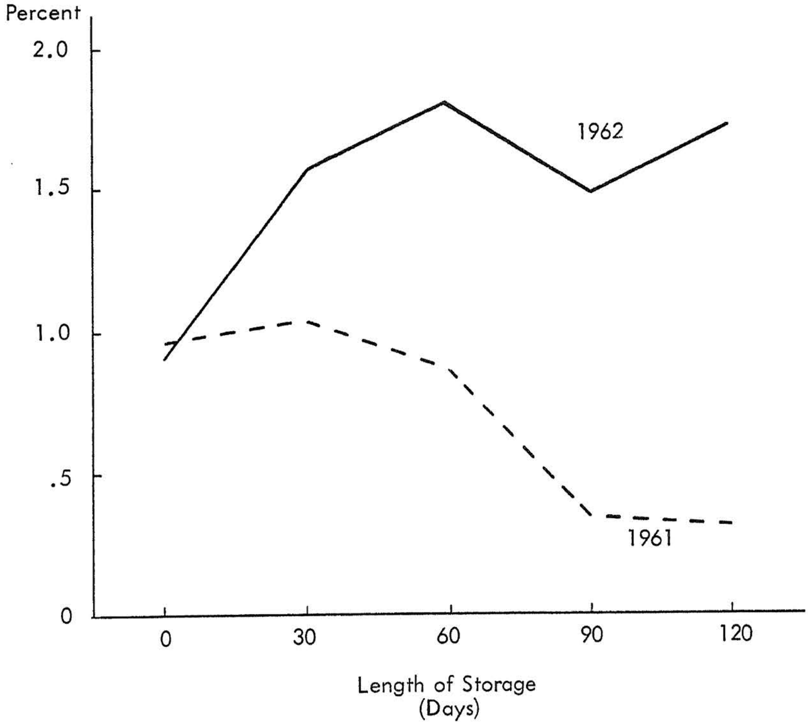

Fig. 11 — The Effects of Storage on the Small Trash Content of Cotton Lint by Length of Storage Period, Missouri, 1961-62.

the situation. For the first 60 days of storage in each of the 1961 and 1962 years, the percentage of large and small trash moved in the same direction. During the last two storage periods of each year the percentage of large and small trash moved generally in opposite directions as would be expected. No explanation could be found for the components of total trash varying in the same direction.

Elongation

The variations in elongation were significant for the 1961 year but not for 1962. The elongation index decreased to a low after 60 days of storage in both years (Figure 12). The reduction in elongation during the first 60 days of storage was great enough to cause the cotton to be designated a full group lower in 1961 and two full groups lower in 1962. During the last 60 days of storage the elongation index increased sufficiently to cause the 1961 crop to be designated a group higher than at storage and the 1962 crop to be designated a group lower than at storage but a group higher than after 60 days of storage.

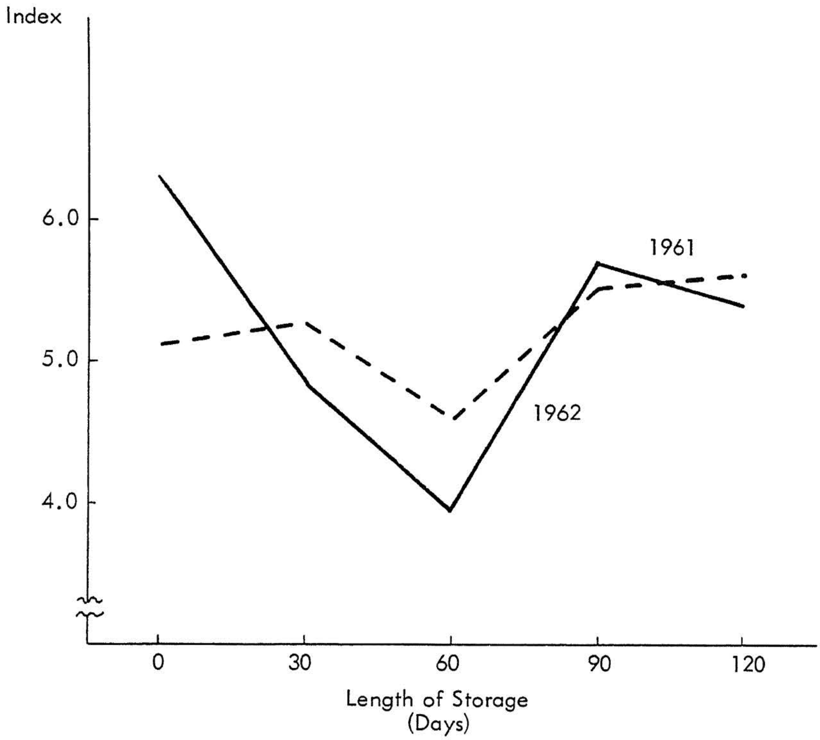

Fig. 12 — The Effects of Storage on the Elogation of Cotton Fibers by Length of Storage Period, Missouri, 1961-62.

EFFECTS OF CHANGES IN GRADE AND STAPLE LENGTH ON MARKET VALUE OF STORED COTTON

Market value of cotton is mainly determined by grade and staple length once the support price-level has been established by the Secretary of Agriculture. Variations in grade and staple length during storage could occur in opposite directions and thereby have offsetting effects on market value. It would, therefore, seem that market value would be the most certain manner of differentiating the extent of value change during storage as reflected by changes in grade and staple length designations. Market value, as discussed here, is based on the loan price and differential at the time of harvest. Therefore, value changes indicate changes in grade and staple length designations as price was not allowed to fluctuate during the storage period.

In terms of market value, the average value per pound of cotton changed very little with length of storage (Figure 13). The average value changes for the entire 25 bales stored in 1961 seem slight when converted to gains and losses

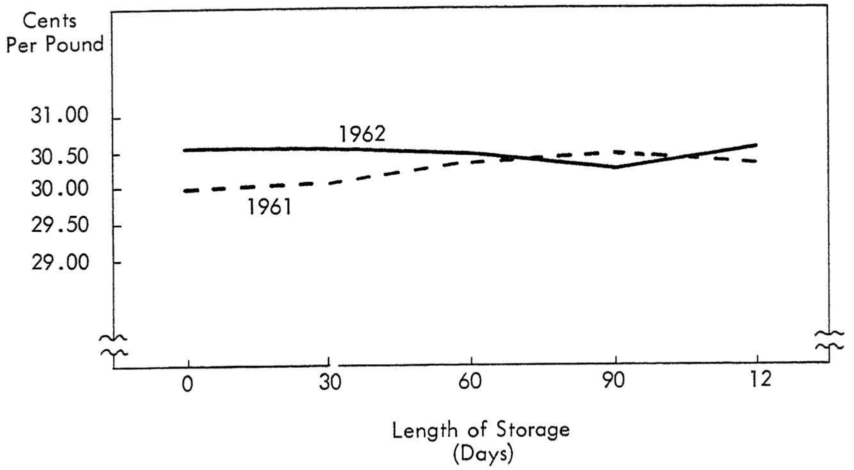

Fig. 13 — Value of Cotton Stored and Changes in Value by Storage Period, Missouri, 1961-62*

* Value expressed is based on the CCC support price for middling 1 inch cotton with appropriate corrections for average grade and staple length of cotton samples.

per 500-pound bale. The data showed a 45 cent per bale gain for cotton stored 30 days and a 65 cent per bale gain for cotton stored 60 days. Cotton stored 90 days had a net gain of $1.15 per bale and a gain of 35 cents per bale when stored for 120 days. These value variations were slight and insignificant.

For the 1962 marketing year the average value per pound of cotton varied almost inversely to 1961. The changes in value by length of storage were not significantly different for the cotton stored in 1962. Converted to gains and losses per 500-pound bales, the data showed that during the first 30 days there was no change in the value of the cotton stored. During the second 30-day period the value of the cotton decreased by 45 cents a bale. Cotton stored 90 days decreased in value by $3 per bale, and during the last 30 days of storage it regained value per bale to the original level at storage time.

In both years cotton stored for 120 days had the same or greater value as cotton ginned immediately after harvest. Variations for shorter periods of storage did occur. Some losses of as much as $3 and some gains of as much as $1.15 were found for the same length of storage for different years. Some explanation of changes in value may be found in the timing of classing during the season.

MOISTURE CONTENT OF STORED COTTON

For the 1961 crop, the moisture content of the 25 bales of seed cotton at storage ranged from 9.2 to 14.0 percent with the average of all tests being 10.8 percent (Table VI). During the entire period of storage little or no change oc-

TABLE VI — MOISTURE LEVEL BY LENGTH OF STORAGE PERIOD FOR COTTON STORED MISSOURI 1961-1962

Length of storage	Mean	Range High	Range Low	Standard deviation
(days)		(percent)		
		1961		
0	10.8	14.0	9.2	1.0
30	10.5	13.0	8.8	1.4
60	11.2	13.5	9.8	0.9
90	11.3	13.2	10.1	0.9
120	10.8	13.1	9.0	1.0
		1962		
0	11.0	18.0	8.1	1.3
30	10.6	13.0	9.2	0.9
60	10.1	12.7	9.4	0.8
90	10.2	12.7	9.3	0.9
120	10.5	13.1	8.9	0.9

curred in the moisture level of the cotton. After 30 days of storage the range in moisture content was from 8.8 to 13.0 percent, 9.8 to 13.5 percent after 60 days of storage, 10.1 to 13.2 percent after 90 days and 9.0 to 13.1 percent after 120 days of storage. The average moisture percentage readings were 11.2, 11.3, and 10.8 for the 60, 90, and 120 days storage, respectively. The low moisture level of the range decreased for the first 30 days then increased up to 90 days of storage before decreasing during the last storage period. This trend is explained by a high proportion of the stored cotton in 1961 being placed in open trailers in a high humidity area near the Mississippi River. The moisture level indicated that most of the cotton stored could be considered "dry" as earlier studies have indicated that seed cotton with moisture levels of 14 percent or less could be stored effectively.[9] Anderson and Waddle reported that cotton stored with moisture levels up to 24 percent had no significant deterioration.[10] This should indicate that while the moisture level of cotton stored during the fall of 1961 had relatively low moisture levels this should in no way invalidate the results of this study.

[9]Zolon M. Looney and Charles C. Speakes. *Conditioning and Storage of Seed Cotton with Special Reference to Mechanically Harvested Cotton,* USDA, mimeographed report (Washington: U. S. Department of Agriculture, March, 1952), p. 2.
[10]Fred B. Anderson and B. A. Waddle. "Effects of Storing Seed Cotton," *Arkansas Farm Research,* Vol. XI, No. 4, (Fayetteville, Arkansas, July-August, 1962). Agricultural Experiment Station.

During the second year the moisture levels of the 43 bales of cotton stored ranged from 8.1 percent to 18.0 percent in moisture at storage. It was noted during the 1962 storage period, like the 1961 period, that the moisture content of the seed cotton changed very little throughout the entire storage period.

The average moisture content of the cotton at storage was 11.0 percent. The range was 9.2 to 13.0 percent after 30 days of storage, 9.4 to 12.7 percent after 60 days of storage, 9.3 to 12.7 percent after 90 days of storage, and 8.9 to 13.1 percent after 120 days of storage. The averages were 10.6, 10.1, 10.2, and 10.5 percent for the 30 60, 90, and 120 days, respectively. The most noticeable change in the limits was the decrease from 18.0 percent at storage to 13.0 percent after 30 days of storage. Given time to adjust to atmospheric conditions it appears that the moisture content of stored seed cotton will be reduced to the maximum of 12 to 14 percent with no artificial drying. Further results would be necessary to substantiate this finding as cotton with higher moisture content was stored during one year only.

As will be pointed out later, there was some indication that while the total moisture content changed little, if any, there was some movement of moisture from lint to seed and vice versa. All of the 1961 cotton had moisture no higher than 14 percent, which is the standard proposed by previous research. In 1962, the design required at least half of the cotton to be harvested with 15 percent moisture or above. It was difficult to get cotton with moisture content above 15 percent and in fact it was necessary to harvest some of the cotton immediately following a rain in order to get the moisture content in excess of 15 percent.

Moisture Content and Selected Quality Measures

Simple linear regression analyses were calculated for moisture content and those fiber quality measures which were found to vary in a statistically significant manner. In each problem moisture content of the cotton mass was the dependent variable (Y) with staple length (classer's call), fiber strength, fiber elongation, upper half mean length, uniformity ratio, large trash content, and small trash content being used as the independent (X) variable in turn.

The results of the regression analyses are provided in Table VII. The coefficient of determination ($r^2 + .39$) for fiber strength and moisture content of the seed cotton mass was significant at the 1 percent level. All other lint quality factors when correlated with moisture content reacted to provide measures too small to be useful. Coefficients of determinations (r^2) of 0.00 to 0.03 were calculated but insignificant.

TABLE VII — SUMMARY OF THE RELATIONS OF SPECIFIED MEASURES OF THE QUALITY OF COTTON LINT AND MOISTURE CONTENT OF THE SEED COTTON MASS AS INDICATED BY REGRESSION EQUATIONS, MISSOURI, 1961-62

Measure of Cotton Quality	Constant (a)	Beta Coefficients (b)	Coefficient of Determination (r^2)
Staple Length	-2.20	0.30	.01
Strength	11.29	-0.12	.39**
Elngation	7.26	0.30	.01†
Upper Half Mean Length	4.98	3.46	---
Mean Length	0.15	1.01	.03
Uniformity Ratio	-0.27	0.15	.02†
Large Trash	0.02	0.18	---
Small Trash	8.80	0.18	---

** Indicates significance at the one percent level. Coefficient of determination was tested for significance using the following formula:

$$F = \left(\frac{r^2}{m-1}\right) \left(\frac{n - m}{1 - r^2}\right)$$

† Less than .005.

SPINNING PERFORMANCE TEST

All cotton stored during the 1961-62 years was subjected to spinning tests at a commercial cotton mill. In addition cotton stored in 1961 was subjected to laboratory spinning tests.

Commercial Mill Tests

The mill determinations were primarily to determine the differences in stored and unstored cotton in mill performance. Mill performance was measured by the extent of ends down, and other stoppages or difficulties in spinning as well as the yarn strength, yarn appearance, nep count and evenness or uniformity of yarn. These commercial mill tests were bale-size-lot tests and were conducted under normal conditions at a commercial mill. No attempt was made to measure the manufacturing waste at the mill due to the high correlation between the Shirley Analyzer nonlint content measurement and the manufacturing waste.

The control lots of cotton for each of the annual groups of spinning tests were cottons not stored but ginned immediately after being picked. They were of the same variety, grown in the same field, and picked at approximately the same time as the cotton with which they were compared. All cotton spun was processed after 120 days of storage. Spinning tests were made for each type of storage. However, the experimental design was such that statistical comparisons of types of storage were not analyzed.

Card Web Neps

As indicated by neps, the spinning performance of cotton stored in 1962 showed slight but hardly significant changes, compared with that of the control lots of non-stored cottons. The average nep count in each lot of the stored cotton was 56. Some lots of non-stored cotton had as low as 42 neps and some as high as 66. Variations tended to be erratic and not associated with any particular type of storage or other factor in the test.

Ends Down

Ends down per thousand spindle hours varied greatly between control lots. Control lot A had 137 ends down per thousand spindle hours while control lot B had only 40. Ends down in lots of stored cotton ranged from a low of 34 to a high of 205. However, there seems to be no connection for a particular type of storage or other factors involved to indicate the factorial influence on the ends down.

Yarn Strength

The average break factor for the tests on cotton in 1962 ranged from 1529 to 1896. All of the stored lots of cotton had a higher break factor than the lower of the control lots. Certain of the stored lots of cotton had as good or better average break factor as the higher of the control lots. Again variations were erratic and not traceable to any factors controlled in the tests.

Yarn Appearance

Yarn appearance grade on control lot A was judged to be C, while on control lot B the yarn grade was B-. However, the attached charts indicate that all of the yarns were nearly, if not, the same grade. The yarn from all of the stored lots of cotton ranged from B- to C with no indication that the type of storage or other factors associated with this test were responsible for changes.

Uster Evenness Test

The Evenness index representing each sample is an average of ten bobbins. The index provided for the Uster evenness test indicates that both of the control lots of cotton would be considered average in evenness. Seven of the 11 lots of stored cotton were ranked one grouping higher. These would be considered "fairly even." The remaining four lots of stored cotton were ranked in the "average" class as were the controls. Likewise, none of the variation in the evenness test could be traced to any particular type of storage or other factor controlled in this study.

Laboratory Spinning Test

For the 1961 crop some small scale spinning tests were made. The results from these tests are given to indicate how closely they were related to the results from the large scale tests made at commercial mills. During the 1961 season, a representative sample was collected for each storage series to be spun in a 20-pound spinning laboratory test. The items measured in the laboratory tests were picker and card waste, nep count, yarn appearance, and yarn strength.

Picker and card waste was the only item measured which varied to a measurable extent. The waste increased from 11.6 percent at storage to 13.9 percent after 160 days.

EFFECTS OF STORAGE ON SEED QUALITY AND GERMINATION

For the 1962 storage period, samples of seed from cotton stored in each of the various types of storage facilities and treatments were analyzed each month to indicate any changes which might be associated with storage. Seed samples were tested each storage period.

The value of the seed from cotton amounts to 10 to 12 percent of the total returns for lint and seed. Most cotton seed from cotton grown in the Delta is sold to an oil mill. A relatively small percentage of the crop is being retained for planting seed. The value of the seed sold to the oil mill is determined mainly by the amount of oil and meal that can be manufactured from the seed. Seed kept for planting purposes is affected in value by the germination of the seed. The value of seed sold to oils mills is based on the grade of the seed which is expressed as a numerical percentage figure. Grade is based upon the quantity index and quality index. The components of the quantity and quality indexes of the seed will be given primary attention in this discussion.

Grade

The relationships between grade of the six samples tested throughout the storage period were not consistent for either quantity index or quality index (Figure 14). For some samples, changes in the quantity index seemed to be responsible for change in grade while in others the quality index was the factor involved. In all cases the grade of the cotton seed decreased for a time as the storage period progressed.

Grade Index

The grade index for all samples decreased slightly over the storage period. This grade index change ranged from as low as 0.5 percent to over 8 percent. This change in grade index tended to cause decreases in the value of seed during storage.

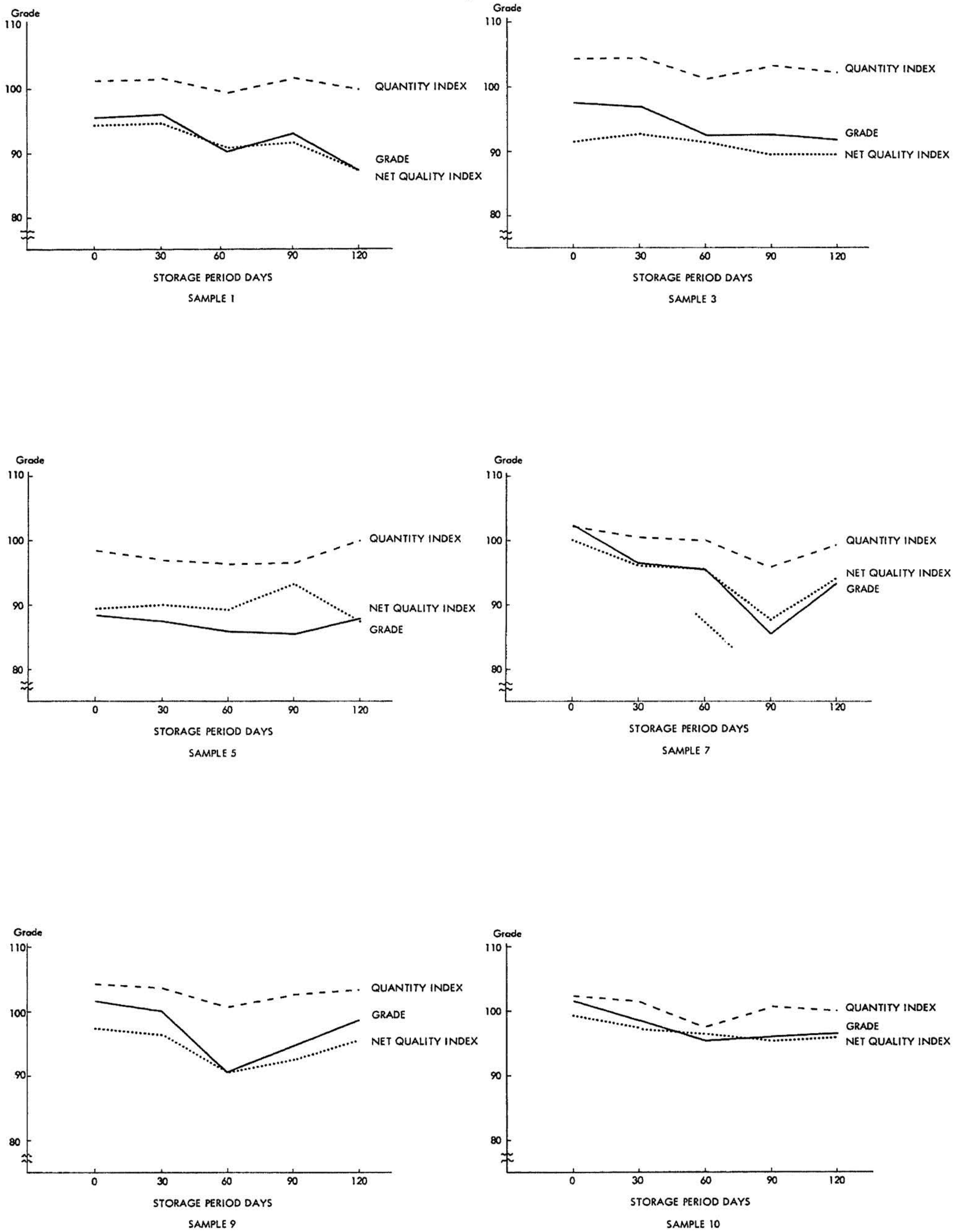

Fig. 14 — Grade Changes of Cotton Seed by Length of Storage Period, Missouri, 1961-62.

Total Foreign Matter Content

The total foreign matter content increased in all cases after the longer periods of storage. Increases in foreign matter were significant when measured as a percent of volume and in units. The results for individual samples were in some cases erratic, increasing rapidly up to some point in the storage period and then decreasing into the final periods.

Foreign Matter Units

The increase in percentage of foreign matter with length of storage as indicated earlier was reflected in the units of foreign matter utilized in calculating the grade index. In all instances the units of foreign matter at harvest time were zero.[11] For all samples there were indications of foreign matter units for 60 days or 90 days and for 120 days of storage.

The average total foreign matter content for all six samples, when measured both as a percentage and in units increased for the first 60 days of storage, decreased for the next 30 days, then increased during the last 30 days (Figure 15). These variations in foreign matter content were significant at the 1 percent level.

Moisture Content

The moisture content for the cotton seed exhibited numerous variations. However, in all cases it was higher at the end of 90 days of storage than when put into storage. The moisture content decreased slightly during the last storage period. (Figure 16).

The variation in moisture content of the seed was statistically significant over the storage periods when measured as a percent. However, the moisture content in units as used to adjust the grade did not vary significantly.

Moisture Units

In all cases the changes in moisture were reflected in units of moisture. All samples had zero readings in moisture units for zero to 30 days of storage. However, beginning with the 60-day storage period, all samples had some moisture units indicated. Likewise, all samples had moisture units indicated for 90 days of storage, but samples one, three, and ten had no moisture units indicated at the end of 120 days storage.

Seed Germination

Seeds from all storage treatments were tested for germination during the 1962 period. The 1962 season produced seed of low germination throughout the Missouri Delta Region, and the germination of the seed stored cotton was no exception. The results reported here are the percent germination of the cotton seed after 12 days of germination time. The germination tests on all seeds were conducted at the end of the storage period in an attempt to overcome a dormant stage of the seed.

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[11]Foreign matter units are assigned as a result of the range in the percentage of foreign matter. A range of foreign matter from zero to seven percent results in foreign matter units of zero.

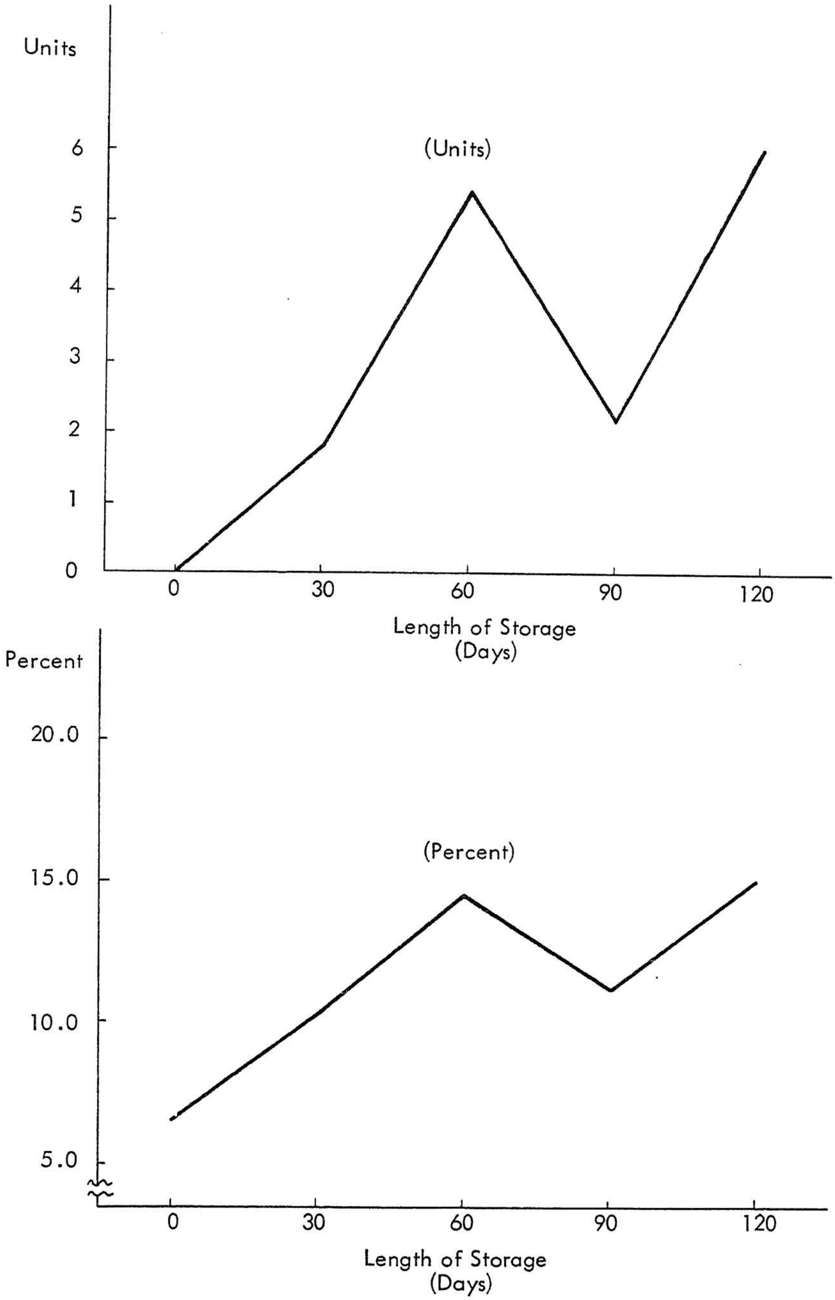

Fig. 15 — The effects of Storage on the Total Foreign Matter Content, as a percent and in units, in Cotton Seed by Length of Storage Period Prior to Ginning, Missouri, 1962.

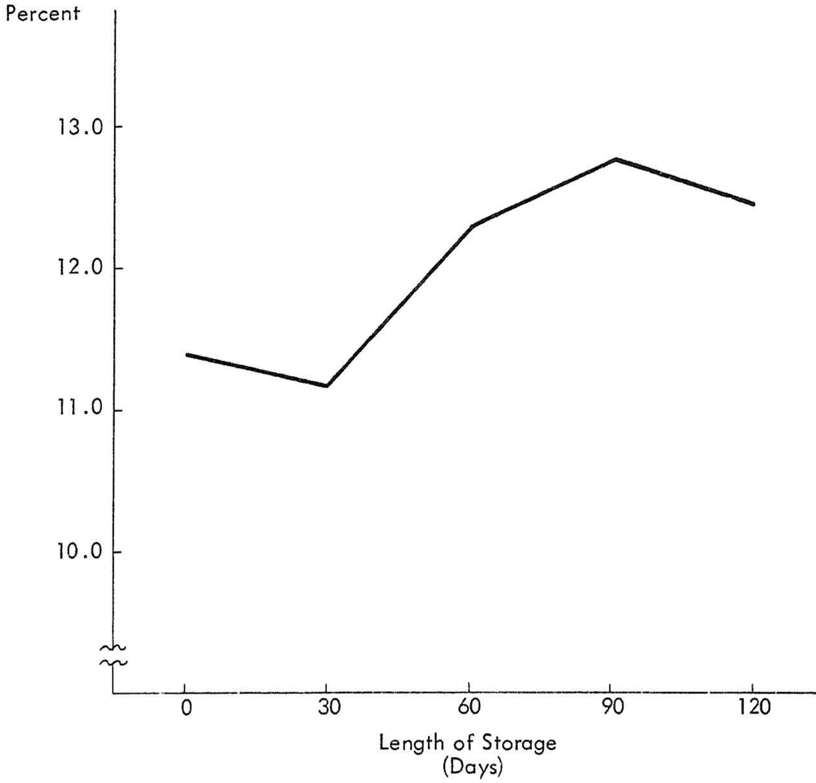

Fig. 16 — The Effects of Storage on the Moisture Content of Cotton Seeded by Length of Storage Period, Missouri, 1962.

It appears significant that in all instances the decrease in germination was less severe after 120 days of storage than after some of the shorter periods of storage.

The variations in germination of the seed from stored seed cotton were highly significant. The changes in germination by length of storage were significant at the 1 percent level. The average germination of the seed from the 42 lots of cotton decreased from 61.8 percent at storage to 56.5 percent after 30 days and to 47.0 percent after 60 days of storage (Figure 17). After 90 days of storage the germination of the seed had increased up to 58.5 percent and was 57.5 percent after 120 days of storage.

Seed germination and moisture level of the seed cotton mass were significantly correlated. However, variations in moisture level of the seed cotton mass will not explain all of the variation in germination. The moisture content of the seed cotton mass decreased slightly during the first 30 days of storage then

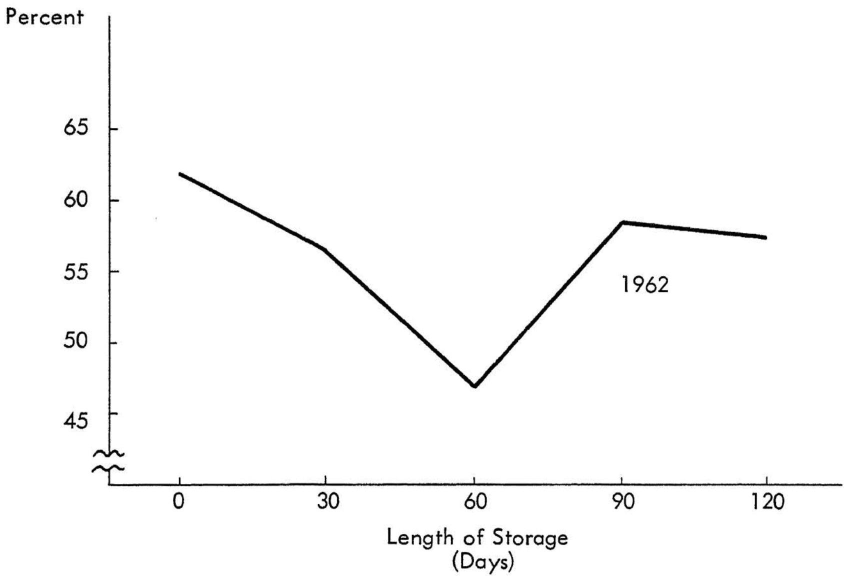

Fig. 17 — The Effects of Storage on the Germination of Seed of Cotton by Length of Storage Period Prior to Ginning, Missouri, 1962.

remained about constant throughout the storage period. The variation in moisture content of the seed doesn't explain the seed germination reaction either. The moisture content of the seed decreased slightly for the first 30 days then increased rapidly for the next 60 days and then decreased slightly during the last 30 days of storage. Though moisture content of the seed cotton mass and seed germination were correlated significantly, there does not appear to be a cause and effect relationship; other factors or combination of factors must be sought to explain the variation in seed germination. It has been suggested by other researchers that high moisture content in the seed cotton mass triggers a reaction which causes heating. The heating, in turn, may cause the germination of the seed to be reduced, but if so, moisture level and germination should have more consistent variations than those reported above. No explanations for the variations in seed germination were apparent from the data available.

Moisture Content and Selected Seed Quality Measures

Simple linear regression analyses were calculated for moisture content of the seed cotton mass and those seed quality measures which were found to vary in a statistically significant manner. In each problem moisture content of the seed cotton mass was the dependent variable (Y) with total foreign matter content of the seed, moisture content of the seed, and germination of the seed being used as the independent (X) variable in turn.

The coefficient of determination (r^2 .46) for seed germination was significant at the 1 percent level. This coefficient would indicate that 46 percent of the variation in seed germination can be accounted for by the moisture content of the seed cotton mass. Coefficients of determination for other seed quality factors and moisture were calculated at 0.06 and 0.09 and were insignificant.

The evaluation of the effects of seed cotton storage on lint and seed qualities indicates that little or no harmful effects result from storage. The exception to this could be the possible reduction in germination that might be associated with storage of cotton being kept for planting seed. As most of the cotton seed goes to commercial channels for crushing this would not seem to be a serious handicap. Some consideration must be given to the costs of storing seed cotton as related to the reduced average ginning costs per bale. (Table VIII)

TABLE VIII — SUMMARY OF THE RELATIONS OF SPECIFIED MEASURES OF THE QUALITY OF COTTON LINT AND MOISTURE CONTENT OF THE SEED COTTON MASS AS INDICATED BY REGRESSION EQUATIONS, MISSOURI, 1961-62

Measure of Cotton Quality	Constant (a)	Beta Coefficients (b)	Coefficient of Determination (r2)
Staple Length	-2.20	0.30	.01
Strength	11.29	-0.12	.39**
Elongation	7.26	0.30	.01[a]
Upper Half Mean Length	4.98	3.46	---
Mean Length	0.15	1.01	.03
Uniformity Ratio	-0.27	0.15	.02[a]
Large Trash	0.02	0.18	---[a]
Small Trash	8.80	0.18	---

** Indicates significance at the one percent level. Coefficient of determination was tested for significance using the following formula:

$$F = \left(\frac{r^2}{m-1}\right) \quad \left(\frac{n - m}{1 - r}2\right)$$

[a] Less than .005.

COSTS ASSOCIATED WITH SEED COTTON STORAGE[12]

Seed cotton may be stored on the farm or at the gin by any of a number of different methods. Whether seed cotton is stored at all and whether it is stored at the farm or at a central location, such as a gin, may well depend upon costs and benefits of such storage and upon who bears and receives them. If stored at the farm, the type of seed cotton storage used will probably depend primarily upon costs and convenience to the farmer. These may well change with individual situations, however. If stored at the gin, the type of storage used will probably depend upon the cost of storing, and the necessity for ease of keeping the cotton of individual farmers separated during the storage period and the potential reduction in ginning costs. Cost will depend upon a number of things, including the capacity of the gin per hour, the volume to be stored, the length of time the cotton is to be stored, the pattern of receipts of the cotton over time, perhaps the amount of cotton to be stored for different people, and the necessity of keeping their cotton separated.

OBJECTIVES

The objective of this phase of study was to estimate the cost of storing seed cotton by selected methods considered to be most feasible in situations where no seed cotton storage facilities exist or where such facilities are inadequate because of volume. A further objective was to present the data in such a way that those interested could adjust the estimates to fit their particular situation.

METHODS AND PROCEDURES

Little cotton has been stored in the Mississippi Delta cotton producing region, except for that on gin yards waiting to be ginned, cotton from which seed is to be saved and small amounts at the end of the season. Those few seed cotton storage operations which do exist have not been in operation very long, and there is considerable variation among them in respect to methods, volume stored, etc.

Thus, it has been impossible to get reliable information relative to all costs of all methods of storage, and for some methods reported here there is no actual cost data available as no such commercial storage operations exist in the Delta or even in the United States. Therefore, a combination of the survey method and the model technique has been used in this study.

Cost estimates were obtained from farmers and ginners who had seed cotton storage operations and from equipment dealers, engineers, and others.

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[12]Material for this section was taken from an unpublished manuscript by Fred B. Anderson, formerly of the Arkansas Agricultural Experiment Station, Fayetteville, Arkansas.

Direct costs were broken down further into overhead and cash costs. These categories largely but not entirely correspond to the categories of fixed and variable costs, respectively. Direct costs include depreciation, interest on investment, repair and maintenance of covers for the stored cotton, equipment used in getting the seed cotton into and out of storage, and containers for the stored cotton. Cash costs include labor, fuel, tractor costs which were charged on a per hour basis, electricity, bagging and ties, and insurance on the cotton. The cost of land was not included in this discussion. Indications are that basket storage uses 1 acre per 400 bales of capacity. Trailer storage would require more, gin-press packages less; on-the-farm storage would have no land cost to the processor.

COSTS OF STORAGE

The bases for computing direct costs per bale are shown in Table IX.

The direct cost per bale for each method of storage was computed for volumes of 500, 1000, and 3000 bales. In addition, three different levels of use of the seed cotton storage facilities during the season are assumed. These levels of use were 1, 2, and 4 times during the season.

As is usually true when fixed costs are prevalent, total direct cost per bale decreased with an increase in both volume and number of times used during the season (Table X). However, the reductions with increases in volume were not as great as might have been expected. This was primarily because it was assumed that for each volume the containers in which the cotton was stored would be used to capacity. In other words, at any particular volume there would be excess storage capacity only to the extent that the loading-unloading equipment would handle more cotton than that assumed to be stored. Although not strictly and exactly so, this assumption is in accordance with reality in the planning of a storage operation as storage containers can be purchased to handle almost any volume of cotton and loading-unloading equipment is not nearly so divisible.

At all volumes and at all levels of use considered here the five-bale trailers and the eight-bale baskets have much higher costs than do any of the other methods. However, the direct cost of storing in five-bale trailers and in five-bale baskets decreases greatly with the level of use. Nevertheless, for the direct cost of five-bale trailers to be as low as that of gin-press packages, bulk bins, and the slide form methods of storage would require a level of use of from eight to 12 times during each season.

With one level of use of the storage containers and a volume of 500 bales, the direct cost of the slide form storage is approximately $1 and $2 less than that of bulk bins and gin-press packages, respectively. At a volume of 1,000 bales, the cost of slide form storage is still lowest, but there is little difference in the direct cost of the slide form, bulk bin, gin-press package, and five-bale basket storage methods. Direct costs total about $3 for all of these methods. At a volume of 3,000 bales, the gin-press package method has the lowest direct cost, $2.10 per bale, and the five-bale basket type of storage is next lowest with $2.67

TABLE IX — ANNUAL OVERHEAD COSTS OF STORING SEED COTTON BY SELECTED METHODS 1/

Method of storage and cost item	Unit	No. of Items	Investment Cost	Useful life	Annual dep'n. 2/	Annual Interest 3/	Repair and maintenance 4/
			($)	(Yrs.)	($)	($)	($)
5-bale baskets 5/							
Baskets	each	1	240.00	20	12.00	7.20	2.00
Running gear	each	1	350.00	20	17.00	10.50	5.00
Fork lift	each	1	4,000.00	15	267.00	120.00	200.00
Tarpaulin	each basket	1	4.50	3	1.50	.14	------
8-bale baskets 6/							
Hydraulic lift	each	1	2,500.00	10	250.00	75.00	125.00
Baskets	each	1	500.00	12	41.67	15.00	3.00
Loading-unloading device	each	1	2,000.00	15	133.33	60.00	100.00
Sheds	sq. ft.		.75	15	.05	.02	------
5-bale trailers 7/							
Trailers	each	1	600.00	12	50.00	18.00	2.00
Shed	sq. ft.		.75	15	.05	.02	------
Packages 8/							
Telescope	ea. system	1	115.00	15	7.67	3.45	5.75
Fan	each	1	250.00	15	16.67	7.50	12.50
Separator	each	1	450.00	15	30.00	13.00	22.50
Gin-press	each	1	4,000.00	15	266.67	120.00	200.00
Air-pipe	ea. system		500.00	15	33.33	15.00	25.00
Installation	ea. system	1	1,500.00	15	100.00	45.00	------
Fork lift	each	1	4,000.00	15	266.67	120.00	200.00
Shed	sq. ft.		.75	15	.05	.02	------
Slide-form 9/							
Forms	ea. system	1	150.00	10	15.00	4.50	------
Loading-unloading device	each	1	1,500.00	10	150.00	45.00	75.00
Tarpaulin	each bale	1	2.50	5	.50	.02	------

Table IX, continued

Method of storage and cost item	Unit	No. of Items	Investment Cost	Useful life	Annual dep'n. 2/	Annual Interest 3/	Repair and Maintenance 4/
Bulk 10/							
200 bale bins	each	1	635.00	5	127.00	19.05	18.00
Tarpaulin	each 200 bales	1	420.00	5	84.00	12.60	------
Loading-unloading device	each	1	2,250.00	10	225.00	67.50	112.00

1/ Includes only costs other than those which would be incurred in the absence of seed cotton storage.

2/ Straight line method of calculating depreciation was used.

3/ Calculated at an annual rate of 6 per cent of one-half the investment cost.

4/ Calculated at 5 per cent of the investment cost except for trailer baskets, trailer running gears and sheds. Repair of these were based on reports obtained by the survey method.

5/ Equipment needed, investment, and length of life were obtained from a gin operator using this type of storage.

6/ Costs are based on data obtained from two operators of gins using this system.

7/ Costs are based on survey data from Louisiana State University and upon data obtained by Missouri and Arkansas personnel from manufacturers.

8/ Costs information was obtained from equipment handlers. In some instances adjustments were made on the basis of discussion with cotton ginners and/or professional workers.

9/ These costs were reported by personnel of the Agricultural Eng. Dept., University of Arkansas and a ginner using a similar method of storing seedcotton.

10/ Costs are those reported by a ginner using this type of storage.

TABLE X — TOTAL DIRECT COST PER BALE OF CAPACITY OF STORING SEED COTTON, BY SELECTED METHODS

Annual volume and cost category	Method of Storage: 5-bale baskets	8-bale baskets	5-bale trailers	Gin press package	Bulk bins	Slide form
	Dollars					
	(Storage containers used 1 time during season)					
500 bales:						
Overhead	7.91	11.85	25.27	3.38	2.12	1.10
Cash	.78	1.82	.70	1.49	2.50	2.50
Total	8.69	13.67	25.97	5.87	4.62	3.60
1,000 bales:						
Overhead	7.33	11.10	25.27	1.90	1.71	.81
Cash	.78	1.82	.70	1.49	2.50	2.50
Total	8.11	12.92	25.97	3.39	4.21	3.31
3,000 bales:						
Overhead	6.94	10.60	25.27	.92	1.45	.62
Cash	.78	1.82	.70	1.49	2.50	2.50
Total	7.72	12.42	25.97	2.41	3.95	3.12
	(Storage containers used 2 times during season)					
500 bales:						
Overhead	4.54	6.65	12.64	3.17	1.46	.84
Cash	.78	1.82	.70	1.49	2.50	2.50
Total	5.32	8.47	13.34	4.66	3.96	3.34
1,000 bales:						
Overhead	3.96	5.90	12.64	1.69	1.05	.55
Cash	.78	1.82	.70	1.49	2.50	2.50
Total	4.74	7.72	13.34	3.18	3.55	3.05
3,000 bales:						
Overhead	3.57	5.40	12.64	.71	.79	.36
Cash	.78	1.82	.70	1.49	2.50	2.50
Total	4.35	7.22	13.34	2.20	3.29	2.86

Table X, continued

Annual volume and cost category	5-bale baskets	8-bale baskets	5-bale trailers	Gin press package	Bulk bins	Slide form
	Method of Storage					
	Dollars					
	(Storage containers used 4 times during season)					
500 bales:						
Overhead	2.86	4.06	6.30	3.07	1.13	.70
Cash	.78	1.82	.70	1.49	2.50	2.50
Total	3.64	5.88	7.00	4.56	3.63	3.20
1,000 bales:						
Overhead	2.28	3.31	6.30	1.59	.72	.41
Cash	.78	1.82	.70	1.49	2.50	2.50
Total	3.06	5.13	7.00	3.08	3.22	2.91
3,000 bales:						
Overhead	1.89	2.81	6.30	.61	.46	.22
Cash	.78	1.82	.70	1.49	2.50	2.50
Total	2.67	4.63	7.00	2.10	2.96	2.72

per bale. These compare directly with costs of $2.72, $2.96, $4.63, and $7.10 for the slide form, bulk bin, eight-bale basket and five-bale trailer types of storage.

The direct costs of slide form and bulk bin types of storage vary little with either increases in the volume stored or number of times the containers are used during the season. This is because a very large portion of the total is accounted for by the cash cost items of labor, insurance on cotton, and tractor costs which were charges on a per hour of use basis. At all levels of use, the direct cost is lower for those methods than for any other method when the volume is 500 bales per season. The slide form method also had lowest direct cost of any method at 1,000 bales regardless of number of times facilities were used.

The direct cost of gin-press packages decreases greatly with an increase in volume stored but does not increase much with an increase in the number of times the storage container is used. This is explained by the fact that overhead expenses are quite high for this method and most of the overhead expenses are accounted for the loading-unloading (packaging) equipment. The expenses of packaging the seed cotton are the same on a per bale basis for a given volume, say 3,000 bales, regardless of whether all 3,000 bales are stored at one time or whether they are stored 1,000 bales at a time during three different periods of time in the harvesting season.

In contrast to the behavior of costs for the gin-press packages, the direct costs of five-bale baskets and five-bale trailers decrease greatly with the number of times the facilities are used during the season and practically none with an increase in the volume stored. The nature of the changes of direct cost of these methods with changes in volume and level of use is explained by the fact that a very large proportion of the total direct cost is accounted for by the storage containers (baskets and trailer beds) themselves. The direct cost of the storage containers decreases in direct proportion with increase in number of times used during the season and none at all with changes in volume in the absence of a change in the number of times used.

The direct costs of the eight-bale baskets are to a large degree accounted for by the large investment in both the baskets and the loading-unloading equipment. Thus, behavior of cost of storing by this method in relation to volume and level of use of the storage containers is intermediate between that of gin-press packages and that of the five-bale trailers and five-bale baskets.

Advantages and Disadvantages of Different Methods

The different methods of storing seed cotton included in this study have certain advantages and disadvantages relative to the other types of storage. The slide form and bulk bin methods of storage are more flexible in that they can be used with a minimum amount of initial investment and should one decide to eliminate his seed cotton storage operation or to change to another type, it could be done with a minimum loss. They are also low-direct-cost methods of storage when only a small volume of cotton is to be stored. Thus, they provide a method for storing seed cotton on the farm at a direct cost which is not approached very closely for small volumes by the other methods. On the other hand, the negative, indirect costs of storing seed cotton cannot be obtained with on-the-farm storage without extremely close cooperation between the farmer and the gin operator, and the direct cost of these methods decreases relatively little with increases in volume to be stored or with number of times the storage containers are used during the season.

Storing in gin-press packages is in some respects the opposite of storing in slide form or bulk bins. There is a relatively high initial investment in packaging equipment and once the operation has been entered into it cannot be eliminated or changed without some expense or loss on the initial investment. On the other hand, costs of storing with this method decrease greatly with increases in volume stored during the season. It is a relatively low cost method at volumes of 1,000 bales or more and negative, indirect costs are associated with this method to a greater extent than with any other method of storage. It has an added advantage for on-the-gin-yard storage in that it requires less space than any other method and risk of fire hazard, hence, insurance costs should be much less than for any other method. Possibly another advantage with the gin-press packages is that if desired, cleaning and drying equipment can be installed in the storage setup.[13]

The five-bale baskets handled with a fork lift truck have a great deal of flexibility and if necessary can be stacked one on top of the other to a depth of at least three high. This would reduce the storage space requirement and the per-bale expense of covering with tarp or sheds. They possibly have an added advantage over other methods except gin-press packages in that should fire break out, baskets with burning seed cotton could be removed from the storage area very quickly and efficiently with the fork lift truck. However, this type of storage does require a large initial investment per bale of capacity and it appears that anticipated use per season should be at least four times or more in order for it to be competitive with some of the other types of storage.

The costs of assembling different volumes of cotton per different densities of production as well as the cost of storing different volumes have been provided. The relevant question at this point becomes one of determining the average cost per bale of ginning cotton for gins with stands of different capacities and systems.

[13]Seed cotton storage research at the University of Arkansas tends to indicate that there is no advantage in drying and cleaning seed cotton prior to storage. An exception to this may be in cases where the seeds are to be saved for planting purposes.

COST RELATIONSHIPS IN HIGH CAPACITY COTTON GINS[14]

To accomplish the objectives of this portion of the study, a synthetic approach using models was used to develop the needed data. Data were obtained on model gins which were reported to be capable of ginning 3, 4, 6, 8, 9 and 12 bales of machine picked cotton per hour. These gins are referred to as models A, B, C, D, E, and F, respectively, in this section.

The cost of ginning on a per bale basis was computed for each model of gin handling specified volumes of cotton. Increases and decreases in volumes were accomplished by varying the number of hours operated each year. The rate of ginning per hour was held constant for each model and for each ginning situation.

ASSUMPTIONS

Each model gin was assumed to be independently owned and operated under conditions of pure competition. The management function was assumed to be performed by a hired employee who had full responsibility for making all management decisions. The functions performed were those associated with receiving and ginning seed cotton.

Effective Capacity of Models

The effective capacity of the models was based on their rated capacity and the proportion of the time that cotton was expected to be ginned while seed cotton was available for ginning. The proportion of time that cotton was expected to be ginned was based on data published by the USDA in 1955.[15]

The USDA reported that cotton was not ginned 30.6 percent of the time that seed cotton was available for machine stripped cotton and 18.5 percent of the time for hand harvested cotton. This was due to stand running empty and to stops for oiling, cleaning, adjusting, and repairing the machinery. It does not include the time lost for major overhaul of machinery and equipment.

It was assumed in this study that cotton would not be ginned 20 percent of the time. This assumption seems valid as machine picked cotton is thought to be between machine stripped and hand harvested cotton from the standpoint of the effects the harvesting method has on the gin operation, and because it is felt that improvements in gin machinery and in gin operating practices since 1955 have tended to reduce the amount of time lost due to stands running empty or to

[14]The data for this section were taken from Southern Cooperative Series Bulletin 88, "Cost Relationships in High-Capacity Cotton Gins" by D. G. Lafferty of the Arkansas Agricultural Experiment Station.

[15]Weaver, Otis T., and McVey, Daniel H., "Using Gin Machinery More Effectively," FCS, USDA, Bulletin 7, 1955, p. 9.

stops. Therefore, the effective capacity of the models was assumed to be 80 percent of the rated capacity. On this basis, the number of bales expected to be ginned per hour by each model was as follows: A, 2.4; B, 3.2; C, 4.8; D, 6.4; E, 7.2; and F, 9.6.

MODELS

Each model used in this study, although varying in capacity, was equipped to perform essentially the same operations on the cotton during the ginning process. Models A, B, and C were one-stand gins; D and F were two-stand gins; and E was a three-stand gin. The gin building for each model was constructed of steel framing, siding, and roofing and concrete floors and bases. Electricity was used as a source of power and butane was used as fuel for drying seed cotton. The office space was assumed to be located in one corner of the gin building and no additional costs were allotted for this space.

The total investment in the ginning facilities ranged from $118,882 for model A to $215,984 for model F (Table XI). Average investment per bale of effective capacity declined from $49,534 per bale for model A to $22,498 per bale for model F (Figure 18). In some cases, the cost for particular items such as

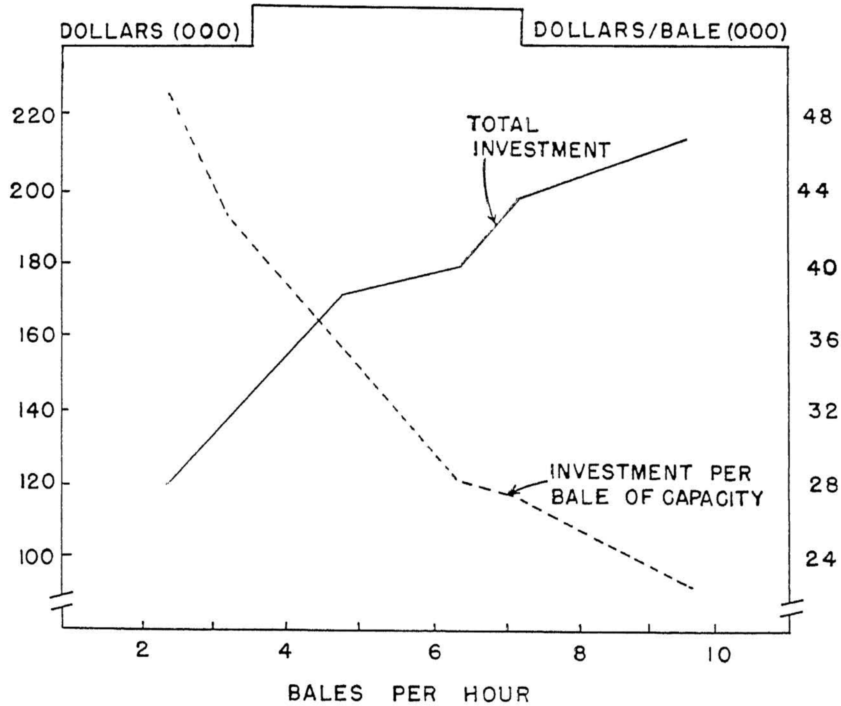

Fig. 18 — Total Investment in Gin Facilities and Cost Per Bale of Effective Capacity, Six Model Gins

buildings and power units was lower for a larger gin than for a smaller one. This was due in part to the specifications of the manufacturers regarding these items. Usually these costs were relatively small when compared to the total cost of the gin facilities.

Model A

The total investment in model A was less than for the other models but the investment per bale of effective capacity was more than twice that of the largest size gin. Machinery, the largest single cost item for each model, accounted for about 62 percent of the total cost. The electric motors required to operate the gin totaled 226 connected horsepower (hp). Five employees were assigned to this model (Table XII).

TABLE XII — ESTIMATED NUMBER OF EMPLOYEES REQUIRED TO OPERATE THE SIX MODEL GINS

Employee	Model A	B	C	D	E	F
	Number					
Manager	1	1	1	1	1	1
Ginner	1	1	1	1	1	1
Ginner's helper		1	1	2	2	2
Pressman	2	2	2	2	2	3
Suction Feeder	1	1	1	1	1	1
Yardmen	[a]	[a]	1	1	1	2
Bookkeeper-weigher	[b]	[b]	1	1	1	1
Total	5	6	8	9	9	11

[a]One of the pressmen worked on the yard in addition to assisting with the press.

[b]The manager kept the books and weighed the cotton.

Model B

The investment cost per bale of effective capacity was $42,698. Higher building costs accounted for about 53 percent of the additional cost of model B. A total of 250 connected hp was required to operate the gin.

Model C

The total investment in model C was $35,667 per bale of capacity. A total of 390 connected hp was required to operate this gin.

Model D

Model D was a double model B gin in that it had two model B stands and was capable of ginning twice the volume of model B. The total investment in this gin was $28,064 per bale of capacity. The building cost was the same and of equal size to the one used for model B. A total of 478 connected hp was required to operate model D.

Model E

Model E was a triple model A gin. It had three stands of the model A type and was capable of ginning three times the volume of model A. The total investment was $27,659 per bale of capacity. A total of 415 connected hp was required to operate this gin.

Model F

Model F was a double model C gin. It had two model C stands and was capable of ginning twice the volume of model C. The total investment in this model was lower than for other models. A total of 534 hp was required to operate this gin.

GINNING COSTS

Based on the maximum number of bales expected to be ginned when the models were operated at their effective capacity without storing seed cotton, the total cost of ginning varied from $10.14 per bale for model F to $14.97 per bale for model A (Table XIII). The effects of changes in the volume of cotton ginned on these costs are discussed in a later section of this report on cost analysis.

Fixed Cost

Fixed cost included salaries, depreciation, interest on investment, plant insurance, taxes and maintenance. Except for salaries, these costs were based on the initial investment in the ginning facilities. The annual fixed cost ranged from a total of $16,305 for model A to $29,437 for model F (Table XIV). On a per bale basis, these costs are discussed in the following sections.

Variable Costs

Variable costs include bagging and ties, gin labor, repairs, power, drier fuel, and miscellaneous items. These costs ranged from $7.77 per bale for model F to $9.73 for model A when the models were operated at the maximum volumes expected when seed cotton was not stored (Table XV). The variable cost items are shown separately in Table XIV.

Analysis of Costs

In this section, only the effects of seasonal volume changes on ginning costs were considered. Increases and decreases in the volume ginned were accomplished by varying the number of hours of operation. The rate of ginning was held constant for each model and for each ginning situation.

Hours of Operation

The costs of ginning were computed on a per bale basis for each model operating up to 6,768 hours during the year (Figure 19 and Table XVI). These

TABLE XVI — HOURS OF OPERATION AND COST PER BALE, SIX MODEL GINS

Hours of operation	Model					
	A	B	C	D	E	F
			DOLLARS			
500	24.80	22.29	19.12	16.39	15.69	14.12
1000	16.94	15.02	13.76	12.32	11.70	10.89
2000	12.95	11.47	11.14	10.21	9.68	9.23
3000	11.79	10.86	10.28	9.56	9.05	8.71
4000	11.16	10.35	9.88	9.24	8.75	8.44
5000	10.80	10.05	9.63	9.03	8.54	8.29
6000	10.49	9.85	9.46	8.89	8.42	8.20
6768	10.42	9.74	9.37	8.83	8.35	8.13

data show that the cost per bale declined for each model as the number of hours of operation increased. Also, for a given number of hours of operation the cost per bale declined as the size of the gin increased. These cost relationships were due in part to the larger volumes resulting from operating gins longer hours and to the increase in the volume expected for the larger gins.

Volume Ginned and Costs

For each model and for each ginning-storage situation, the cost per bale declined as the volume ginned increased. In each case, the cost declined more rapidly in the lower than in the higher volume ranges. At the lower volumes, the costs were higher for the larger than for the smalled sizes of gins. However, the reverse was true for the larger volumes. At each volume in excess of 5,000 bales and not exceeding the maximum volume expected for each model, the cost varied less than $1.00 per bale among the models.

The cost of ginning the maximum volumes expected when seed cotton was stored for short periods ranged from $1.48 per bale for model F to $3.45 for model A less than the cost of ginning the maximum volumes expected when seed cotton was not stored. For long time storage these costs ranged from $2.00 per bale for model F to $4.71 for model A lower than when seed cotton was not stored. Although these savings in ginning costs are relatively large, it is necessary to consider both the cost of storing and the cost of assembling seed cotton before conclusions may be drawn.

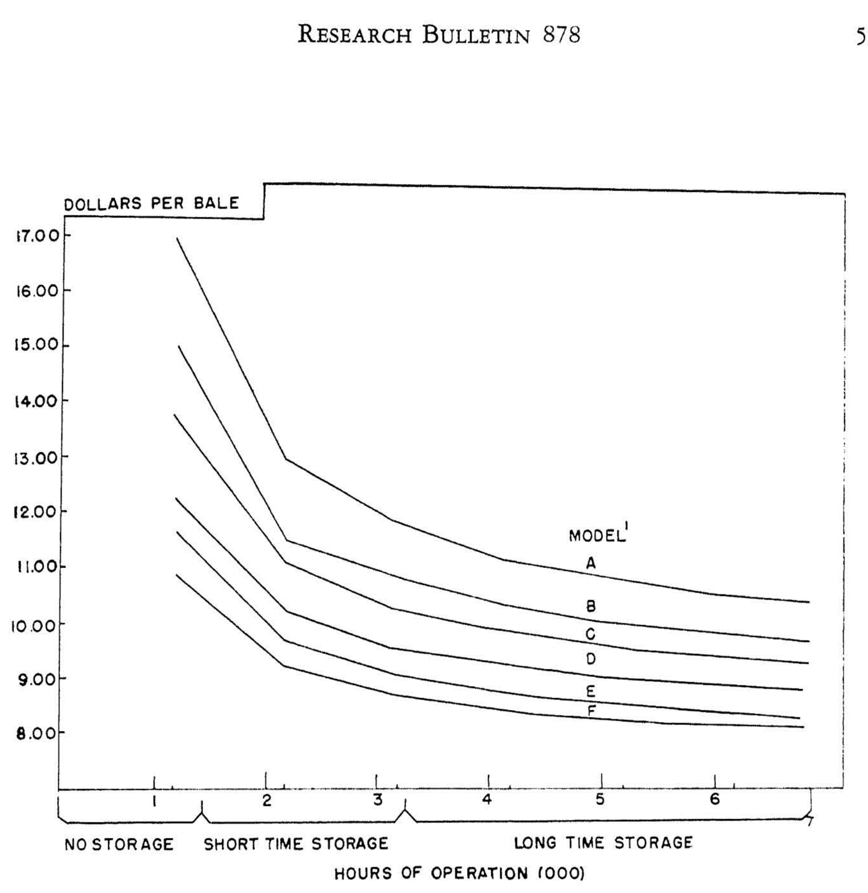

Fig. 19 — Hours of Operation and Cost Per Bale, Six Model Gins

ALTERNATIVE GINNING SYSTEMS[16]

Data on the Tennessee ginning industry indicates gin capacity has been increased over the past 57 years to the necessary level for meeting peak season ginning during any year (Table XVII). Although the number of gins in Tennessee declined and annual ginnings increased from 1906 to 1962, the total ginning capacity of all gins for 12 hour shifts has about kept pace with the increase in ginnings. While the number of gins declined from 702 in 1906 to 273 in 1962, the number of gins stands per gin increased 89 percent and the saws per gin increased 145 percent. During this period, gin capacity as an average per hour increased 67 percent per saw, 114 percent per gin stand, and 333 percent per gin, (Table XVIII). These trends are visible in other Delta states though the exact degree may vary from the Tennessee data.

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[16]Data for this section taken from bulletin, "Factors Associated with Cotton Ginning Problems in Tennessee," by B. D. Raskopf.

TABLE XVII — GINNING CAPACITY OF TENNESSEE GINS, 1906-1962

Crop year	Active gins	Total ginned (000)	Ginning capacity 12-hour shifts (000)	12-hour shifts needed to gin crop	Crop year	Active gins	Total ginned (000)*	Ginning capacity 12-hour Shifts (000)	12-hour Shifts needed to gin crop
	No.	Bales	Bales	No.		No.	Bales	Bales	No.
1906	702	304	8.4	37	1945	382	450	13.0	35
1915	562	296	9.6	31	1946	379	510	13.3	39
1920	480	315	9.6	33	1947	377	507	13.9	37
1925	476	513	10.9	48	1948	382	641	14.5	45
1930	453	371	11.3	33	1949	377	622	14.7	43
1931	444	578	11.5	51	1950	365	404	14.6	28
1932	431	467	11.6	41	1951	359	525	14.7	36
1933	433	429	12.1	36	1952	350	621	14.7	43
1934	432	397	12.5	32	1953	344	686	14.8	47
1935	438	316	13.1	25	1954	342	534	15.0	36
1936	431	422	12.9	33	1955	335	613	14.7	42
1937	434	633	13.0	49	1956	330	527	14.9	36
1938	433	474	13.0	37	1957	321	404	14.4	28
1939	423	432	13.1	33	1958	295	411	13.6	31
1940	423	503	13.1	39	1959	290	642	13.6	48
1941	418	574	13.0	45	1960	280	571	13.7	42
1942	408	603	13.1	47	1961	277	550	13.9	40
1943	400	480	13.2	37	1962	273	548	14.1	39
1944	391	538	13.3	41	Avg.	444	444	11.9	38

* Running bales.

Source: Computed form annual reports of the Bureau of the Census and unpublished studies made by the Tennessee Agricultural Experiment Station, 1928 to 1962

TABLE XVIII — ACTIVE GINS, CLASSIFIED BY NUMBER OF STANDS AND SAWS, AND BY GINNING CAPACITY, TENNESSEE, 1906-62

Crop year	Active gins	Gin stands		Gin Saws			Gin capacity per hour			
		Total	Per gin	Total	Per gin	Per stand	Per gin	Per stand	Per saw	All gins
0	No.	No.	No.	No.	No.	No.	Bales	Bales	Lbs.	Bales
1906	702	1244	1.8	8405	120	68	1.2	0.7	5.0	842.4
1915	562	1293	2.3	8794	156	68	1.7	0.7	5.4	955.4
1932	431	1422	3.3	9675	225	68	2.7	0.8	6.0	1163.7
1937	434	1432	3.3	10859	249	76	3.0	0.9	6.0	1302.0
1942	408	1347	3.3	10319	254	77	3.2	1.0	6.3	1305.6
1947	377	1282	3.4	10128	269	79	3.7	1.1	6.9	1394.9
1952	350	1190	3.4	95200	272	80	4.2	1.2	7.7	1470.0
1957	321	1130	3.5	91530	285	81	4.5	1.3	7.9	1444.5
1962	273	940	3.4	80146	294	85	5.2	1.5	8.8	1406.4

Source: Computed from annual reports of the Bureau of the Census and unpublished studies made by Tennessee Agricultural Experiment Station, 1928 to 1962.

UNUSED GIN CAPACITY

One approach to the problem of unused gin capacity is by shortening the period of time when the gin is used for business during the 200-day season when cotton is harvested in the Delta. This would mean that ginning would end soon after the 75-100 day operating period or operate only a few days a month after the peak of the season. Many ginners are making special efforts to decrease the gin down time during the actual periods of operating. Some have provided additional facilities for unloading long trailers so cotton is always available for ginning, installed bulk or master seed control systems to keep gins supplied with cotton all of the time, and devised split stream arrangements for drying, overhead cleaning, and lint cleaning.

A second possible approach to the problem of unused gin capacity is to store seed cotton during peak periods and gin it during slack periods. This method offers several possible alternatives: (1) ginning cost per bale can be stabilized for operating gins near the most efficient rates for a longer period of time, (2) total volume ginned can be increased in many instances by providing storage facilities,(3) farm trailers can be returned more rapidly in many instances, (4) storage of seed cotton can be used in conjunction with modernized and high speed equipment or in lieu of modernized and high speed equipment to increase annual volume and total ginning per gin.

The added investments and operating costs represented by the additional auxiliary pieces of equipment in gins during the past 30 years have contributed to the upward trend in ginning costs. From 1941 to 1961, ginning costs increased 3 times per bale as an average throughout the Delta. The average replacement value per gin rose by over 800 percent during the period 1941-1961. Annual depreciation and interest on investment per gin increased from $1,384 in 1941 to $11,166 in 1961. All fixed and operating costs per bale showed considerable increase from 1941 to 1961. As gins modernized and gin investment increased, there were annual increases in costs of labor and management, fuel and power, repairs and maintenance, insurance, taxes, and sundries.

During the period 1958 to 1961, gin modernization consisted of the addition of several new and larger gin plants, the remodeling to gin equipment, machinery, and buildings and the installing of much auxiliary gin equipment. However, during these four years, volume per gin rose from 1,382 to 1,987 bales and ginning cost per bale declined from $23.32 to $19.62 in Tennessee.

INVESTMENT NECESSARY TO INCREASE CAPACITY

The average replacement value of 335 gins in Tennessee in 1955 was $58,540 per gin. By 1962 this value had risen to $117,275 per gin. Modernization of gins during the 8 years, together with advancement in price of machinery and buildings, is of major importance in contributing to higher gin investment. During the same period the hourly capacity per gin increased from 4.4 to 5.2 bales and many gins installed auxiliary gin equipment as indicated earlier.

Data indicate that, in gin remodeling, an increase in capacity of 1 bale per hour was associated with an increase in gin plant investment of about $8,550 in 1955; by 1962 this figure had increased to $15,000. A gin with an average hourly capacity of 4.2 bales per hour in 1962 had a gin replacement value of $103,000. On the average, a gin in this group could be converted to a capacity of 8 bales per hour at a cost of $57,000, and to 12 bales per hour at a cost of $117,000.

INCREASED COST FACTORS ASSOCIATED WITH GINNING PROBLEMS

Ginning Cost per Bale

From 1928 to 1962 it was found that the total ginning cost increased about 56¢ per bale annually. Major fixed and operating costs per bale showed annual average increases of 26.2¢ for depreciation and interest, 9.9¢ for management, 8.2¢ for labor, 5.5¢ for repairs and maintenance, 4.8¢ for power and fuel, 4.2¢ for bagging and ties, 2.8¢ for taxes, 2.0¢ for insurance and 2.9¢ for miscellaneous costs. Since 1941, the increase of each major fixed and operating cost has been at a faster rate than the increase in bales per gin. While volume per gin increased 1.4 times from 1941 to 1962, the ginning costs per bale increased 6 times for depreciation and interest, 5.3 times for taxes, 3.8 times for management, 3 times for labor, about 2 times for wrapping, fuel, power, repairs, maintenance, insurance, and miscellaneous costs.

Increased Cost Difficulties and Approaches to Problems

With the upward trend in all fixed and operating costs of ginning in recent years, many ginners are faced with several alternatives. The trend in the ginning industry in the Delta is toward higher ginning capacity in bales per hour in an attempt to minimize the costs of ginning and at the same time cope with the problems associated with rapid changes in methods of harvesting. A survey of ginners in 1962 indicated that within the next 10 years gin capacity per gin for all active gins is likely to average around 8 bales per hour.

ECONOMIC IMPLICATIONS OF ASSEMBLING, STORING, AND GINNING COST COMBINATION

To provide a usable example of how to use the data in this report, it is first necessary to make adjustments to get all costs and considerations in the same terms. Most commonly, gin turnout is spoken of in annual volume and not in hours of operation per year. If the gin plant manager is interested in a gin size, the same as Model A with a 3 bale per hour rated capacity or a 2.4 bale per hour effective capacity, then the average cost curve for Model A can be taken from Figure 19 to appear as in Figure 20. As the effective capacity is 2.4 bales per hour of operation, this multiplied by the number of hours gives the annual volume corresponding to length of operation and included is a sub-scale on the longitudinal axis.

It has been determined that this size of gin plant, operated for 1296 hours during the harvesting period, will gin about 3100 bales of cotton. Volumes anticipated in excess of 3100 require consideration of storage cost. Storage facilities for 500 bales of seed cotton will cost \$8.47 if the 8-bale basket is used twice during the year. However, if annual volume is increased from 3100 to 3600 bales the average cost of ginning decreases from about \$15.20 at 3100 to \$14.50 at 3600. This is a savings in cost of \$.70 on each of the 3600 bales, not on just the added 500 bales. Therefore, the \$8.47 per bale cost of storing the added 500 bales must be allocated over the 3600 bales of volume. This is easily accomplished by finding the total cost of storing 500 bales (500 x \$8.47 = \$4235) and dividing the total cost by 3600. This gives a cost of \$1.18 per bale for storage. Similar calculations will give \$1.88 and \$3.55 per bale storage costs for 1,000 and 3,000 bales respectively. The reduction in ginning costs would be \$1.40 (\$15.20 - \$13.80) for 1000 bales and \$3.00 (15.20 - \$12.20) for 3000 bales.

This, then, would indicate that in no situation utilizing 8-bale basket storage for 500, 1000, or 3000 bales, would the savings in gin costs be equal to or greater than the cost of storage. At 500 bale storage capacity a \$.70 savings versus \$1.17 cost; at 1000 bales storage a \$1.40 savings versus a \$1.88 cost; and at 3000 bales storage a \$3.00 savings versus a \$3.55 cost.

Words of caution are in order. Paramount in importance is the fact that only the *time* dimension has been accounted for in this analysis. Most ginners presently storing seed cotton in the Delta indicate that the *rate* dimension is the most important aspect of seed cotton storage and plant operation. They indicate that output increases up to 20 percent due to groupings and holding for larger

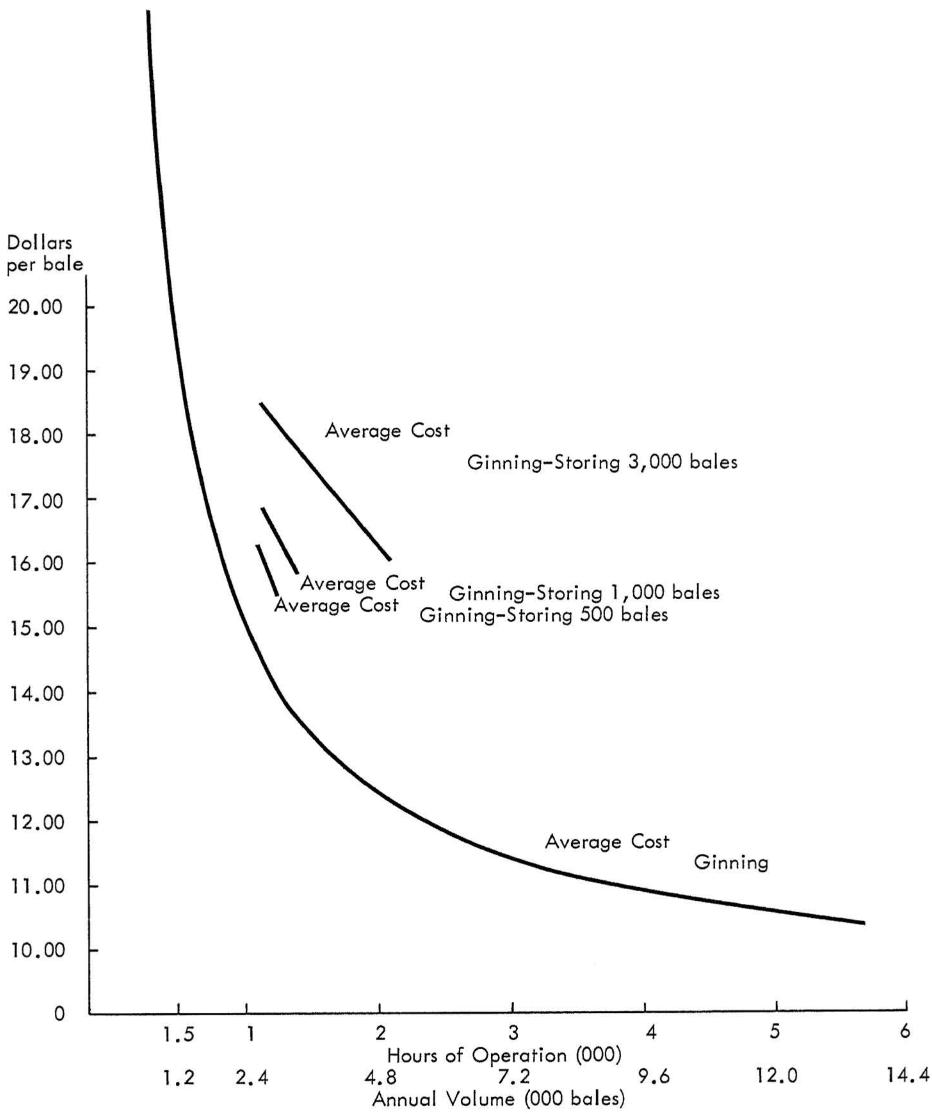

Fig. 20 — Average Ginning Costs for Gin of given Capacity using Different Amount of Storage for Seed Cotton to vary Output.

lots, labor efficiency increases greatly as cotton is available during wet or other weather conditions unfavorable to harvesting. Some ginners indicate that grade and staple length measurements tend to improve as a result of larger lots of cotton with uniform conditions for ginning. Other benefits are also claimed.

Rate dimension may be the most critical factor in deciding to store or not store seed cotton. Additional data are necessary before quantitative analysis can be presented on the benefits from more efficient gin operations utilizing seed cotton storage. Some consideration was given to this efficiency of operation in assuming that the storage facility was used twice annually with an increase in volume equal to capacity only.

While the costs of storage were not offset by the savings on ginning costs in the above example, other types of storage could have been chosen with differing results. Five-bale baskets, for example, utilized twice annually, result in costs of $.74, $1.03 and $2.14 for 500, 1000, and 3000 bale storage, respectively. Thus, for storage facilities above the 500 bale amount, savings will more than offset the costs of storage. Bulk bins, gin press packaging and slide forms are even less expensive methods of storage than is the 5-bale basket system.

Similar analyses can be followed for each size of gin model in turn; or cost data from gin operators can be utilized instead of the model data.

If it is deemed necessary to consider assembly costs in addition to storage costs for increased volume the procedure would be the same as before. This situation is illustrated by the average cost ginning-assembling curves (Figure 21). This curve is simply the addition of the assembly costs given in Table 5 to the section of the curve representing 100 bales per square mile density of production. The average cost ginning-storing-assembling curve is derived by adding both the assembly and storage costs to the ginning cost curve.

SUMMARY AND CONCLUSIONS

Cotton gin operators throughout the cotton belt accept the situation of excess capacity during all but four to eight weeks each year. Yet the paradoxical situation of not being able to gin patrons' cotton as rapidly as it arrives at the gin during this four to eight-week period causes many gin owners to seek ways of processing cotton more rapidly. Some gin operators increase the capacity of their plant with new high speed equipment. Others store cotton during the peak of the period to delay the ginning process into the following weeks when their gin's capacity will accomodate the volume. Likewise, these methods offer possible ways of increasing annual volumes of ginning and thus lowering ginning costs per bale. The costs of assembling larger volumes, the effects and cost of seed cotton storage, and the effects of capacity and annual volume on gin costs were not readily available to ginners. This study was designed to provide such information.

Costs associated with the movement of seed cotton from the field to the gin were estimated from data obtained by personal interviews with cotton producers and custom harvesters. The most common method of moving cotton from the field to the gin was found to be a pickup truck pulling a 5-bale cotton trailer.[17] Investment and operating costs were estimated and average assembly costs were computed for four levels of cotton production density. Data obtained from the Louisiana Agricultural Stabilization and Conservation Committee indicated densities of 50, 100, 200, and 300 bales per square mile would embrace nearly all production in the two areas studied. Average cost curves indicate that assembly costs per bale increase with distance from the gin, but at a decreasing rate for all densities of production considered. For example, at a density of 50 bales per square mile, a 1,000-bale increase in the amount of cotton available to the gin, from 2,000 to 3,000 bales, increases average assembly costs 22¢ per bale. A similar increase from 29,000 to 30,000 bales only increases average assembly cots 6¢ per bale.

Since the alternative of increasing the volume of cotton processed in a gin by increasing the intensity of production in the existing supply area is severely limited by the acreage control program and the patterns of technological adoption, the volume of cotton handled annually by a gin can be increased most effectively by increasing the size of the supply area. Consequently, distance hauled

[17]In certain areas the most common method of moving cotton from the dealer to the gin is with a pickup truck pulling two five-bale trailers. Certain states prohibit the use of two trailers behind a pickup truck because of excessive length. A thorough discussion of the costs of assembling cotton when two five-bale trailers are used can be found in Tennessee Bulletin 366.

and, thus, assembly costs per bale, increase in the manner indicated earlier. Economies associated with increasing gin size must, therefore, be examined in combination with the dis-economies of increasing assembly costs.

The variations in lint quality associated with length of storage were economically unimportant. Some quality measures had statistically significant variations in one or both years while others did not vary in a statistically significant manner.

(1) Lint quality measures which exhibited statistically significant variation during one harvest season but not another were: fiber strength, 1962; mean length, 1961; and elongation, 1961.

(2) Lint quality measures which varied in a statistically significant manner during both years of storage were: staple length, uniformity ratio, upper half mean length, large and small trash content.

(3) Moisture content of the seed cotton mass was significantly correlated with fiber strength only.

While the variations for mean length, fiber strength, staple length, uniformity ratio, and large and small trash content were significant in one or both years, they were neither consistent for both years nor were they consistent with expectations based on previous results.

Variations in fiber elongation and upper half mean length varied inversely with each other. Upper half mean length increased for the first 60 days of storage and then decreased for the second 60-day period. Fiber elongation decreased during the first 60 days and then increased during the second 60 day period.

There are no indications that storage had any harmful effect on the spinability or spinning qualities of the cotton. Likewise, there are no indications that storage would have any effect on the end evaluation of the yarn spun from cotton stored prior to ginning.

Manufacturing or picker and card waste for the 1961 period shows a consistent though statistically insignificant trend. The picker and card waste for the 1961 season continued to increase throughout the storage period. This increase in picker and card waste is not to be taken as indicative of commercial mill test results. Cotton spun on the small scale test had no cleaning during the ginning process. While the picker and card waste was not obtained for the 1962 commercial mill test, the nonlint content tests made on the control and the 120 days storage of these cottons were not significantly different. This would indicate that the amount of trash discarded during the picking and carding process did not increase when the cotton was ginned in a commercial gin equipped with cleaning equipment.

Other variations which occurred when the cotton stored for varying periods of time was compared with the control lots were erratic and inconsistent.

Attempts were made to define the variations that might have occurred in the spinability and spinning performance of the cotton in terms of moisture content of the cotton prior to ginning. All such attempts were unsuccessful as there seemed to be no relation to the moisture content of the seed cotton mass prior to storage and during storage and the spinning performance of the cotton.

The grade index of all cotton seed tested decreased slightly during storage, but the decrease was not statistically significant. The decreases in grade index after 120 days of storage ranged from 0.5 percent to slightly over 8 percent. Some decreases in grade index resulted from a decrease in the net quality index and others from a decrease in net quantity index.

Total foreign matter content and moisture content measured as a percentage of the volume of the seed were the only factors involved in the grading of the seed which varied significantly throughout the storage period.

The free fatty acid content of the oil increased slightly but insignificantly during storage.

The variations in seed germination were highly significant. The germination of the seed decreased during the first 60 days of storage. Germination of the seed increased during the third storage period, then decreased slightly during the last 30-day period.

The moisture content of the seed cotton mass was highly correlated with seed germination. Correlations between total foreign matter and moisure content of the seed and moisture of the seed cotton mass were not significant.

Costs of storing seed cotton were estimated for six different methods or types of storing seed cotton at each of three different volumes and three levels of use of the seed cotton storage container during the harvesting, ginning season.

Costs were divided into direct and indirect categories. Direct costs are those directly attributable to the seed cotton storage operation and indirect costs are those charges in ginning cost or value of lint which accrue because the seed cotton is stored prior to being ginned. Direct costs were further broken down into overhead and cash costs. Cash cost items were labor, fuel, tractor cost, electricity, bagging and ties, and cotton insurance. Overhead costs were depreciation, interest, repair and maintenance on the seed cotton storage containers, and facilities used to get the cotton in and out of storage.

At a volume of 500 bales per season, slide form storage was calculated to be the lowest direct cost method regardless of the number of times the facilities were used during the season. There is little difference in the direct costs of slide form and gin-press package methods at a volume of 1,000 bales. Also, when 1,000 bales are stored and the storage containers are used four times during the season, five-bale baskets have a direct cost approximately the same as that of the slide form and gin-press package methods. At a storage of 3,000 bales, the gin-press package method has a lower per bale direct cost than the other methods. However, when the facilities are used four times during the season there is a difference of only 60 to 80 cents per bale between the gin-press package method and the 5-bale baskets, bulk bins, and slide form methods of storage.

Because the slide form and bulk bin methods of storage require a very small initial investment and have relatively large cash costs, the total direct cost of these methods varies only a relatively small amount with increases in volume stored and the number of times the storage container is used per year. The gin-press package method requires a large investment in equipment required to make the packages and get them into and out of storage. Thus, total direct cost for this method varies greatly with changes in volume stored and only a small amount with changes in the number of times the storage container is used during the season. No labor in addition to that available at most gins but a large investment in storage containers is required by the five-bale trailer and five-bale basket methods. Thus, the direct costs of these methods vary almost proportionately with changes in the number of times the storage containers are used during the year and very little with changes in volume. An eight-bale basket storage operation requires a relatively large investment in both storage containers and in equipment required to get the cotton into and out of storage. Thus, the behavior of changes in costs with this method, as volume and number of times the storage containers are used during the season, is intermediate between the slide form method and other methods of storage.

There are advantages and disadvantages to all of the different types of storage. However, the five-bale and eight-bale baskets are clearly the most expensive types of storage under the conditions of this study. The slide form and bulk bin methods require low investment costs and are relatively inexpensive when only a small volume of cotton is to be stored. They are also very adaptable to on-the-farm storage and less adaptable to gin yard storage. Gin-press packages and five-bale baskets require a large investment per bale of storage capacity but have a low cost at high volumes and a large number of times of use per season, respectively. Thus, the particular type of storage to be used will depend upon the individual situation.

The cost of ginning on a bale basis declined for each model as the number of hours of operation and the volume ginned increased. Also, for a given number of hours of operation, the cost declined as the size of the gin increased. At the lower volumes, the costs were higher for the larger than for the smaller gins. However, the reverse was true for the larger volumes.