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RAYON PRICES: PAST, PRESENT, AND FUTURE

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CONTENTS

INTRODUCTION

The price at which rayon is now selling and will sell in the future is of tremendous significance in the intense competition between this fiber and cotton. In order to provide basic information for the cotton industry on this subject, a study of rayon prices was made at the Southern Regional Research Laboratory in 1946 and early 1947 as part of the cooperative "Study of Agricultural and Economic Problems of the Cotton Belt," sponsored by the Special Subcommittee on Cotton of the House of Representatives (Project V, pages 375-488). 1/

1/ Washington, U. S. Government Printing Office, 1947.

The Southern Regional Research Laboratory has had a continuing interest in the subject of competition between cotton and rayon, because of its research program to develop new and extended uses for American cotton. Since the above study was made, there have been large increases in the cost of making rayon, and most rayon prices have risen substantially. The present study has been prepared to provide those interested in cotton with up-to-date data on rayon prices. It also provides limited data on prices of other synthetic fibers.

Rayon is a cellulose-base, man-made fiber, the cellulose being derived from wood pulp and cotton linters. It is made in the United States by 3 different chemical processes: (1) viscose, (2) cuprammonium, and (3) acetate. Viscose and cuprammonium rayons are both, chemically, regenerated cellulose and have the same general properties, although they differ in some respects from each other. Acetate rayon, however, is chemically an acetate ester of cellulose and has characteristics entirely different from those of viscose and cuprammonium rayons. It frequently now is termed estron instead of acetate rayon. Of the total production of 1,124 million pounds of rayon in the United States in 1948, 65 percent was viscose; 1 percent, cuprammonium; and 34 percent, acetate.

Both viscose rayon and acetate rayon are made in two forms: (1) continuous filament yarn, which is continuous in form like silk, and (2) cut staple or staple fiber, which is somewhat similar in form to cotton and other short fibers. Cuprammonium rayon is made only in continuous filament yarn form. Until the late 1930's, practically all rayon manufactured in the United States was continuous filament yarn, but since then rayon staple has become very important. Of the total domestic rayon production in 1948, 76 percent was continuous yarn and 24 percent was staple. 2/

Rayon staple competes with raw cotton as a raw material for cotton system spinning mills. Its commercial development opened the door to the vast cotton spinning industry, which comprises the bulk of all textile-yarn producing facilities, as a market for rayon. At the same time it gave cotton mills, for the first time, an alternative to cotton as a raw material. Continuous filament rayon yarn, made originally in yarn form, competes with cotton yarns as a material for weaving and knitting into textile fabrics. Of course, the primary focus of competition between the two fibers is in the manufactured textile, when they compete for the final consumer's dollar. How rayon compares in price with cotton at each of these levels of competition is discussed in this report.

RAYON STAPLE PRICES 3/

Viscose staple was priced at 60 cents a pound when it was first placed on the market in 1928, but after 1930 the price was cut from

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2/ Rayon Organon 20, pages 20 (February 1949).

3/ Rayon price quotations throughout this report are from the Rayon Organon.

time to time until it reached a level of 25 cents a pound in 1937. This price remained stable until November 1946, except for a temporary drop to 24 cents for several months during 1943 and 1944. Acetate staple, not introduced until 1936, sold for 80 cents a pound at first, but by the end of 1936 was down to 54 cents a pound and by 1940, down to 43 cents. The price stayed at this level through World War II except for a temporary cut by some companies to 38 cents a pound for various periods between October 1944 and April 1946. In October 1946, viscose staple rayon was priced at 25 cents and acetate staple rayon at 43 cents per pound.

Since the removal of O. P. A. price ceilings in the fall of 1946, there have been four increases in the price of viscose staple, but only two, followed by a cut, in the price of acetate staple. The last price increase for viscose staple, in August 1948, raised its price to 37 cents, or 12 cents more than the wartime price. The last price increase for acetate staple, in January 1947, raised its price to 48 cents, or 5 cents more per pound than the O. P. A. ceiling level, but on March 1, 1949, the price was reduced to 42 cents per pound. One effect of these price changes has been to reduce the advantage in price of viscose staple, compared to acetate staple, from 18 cents per pound during World War II to 6 cents per pound after March 1, 1949.

Comparative Raw Cotton Prices

Before indicating how rayon prices compare with cotton prices, it should be pointed out that the quotations usually given for the two fibers are not at all comparable. In deciding which fiber is lowest in cost, mills must consider the following:

1. Rayon quotations are on a delivered-at-mill basis 4/ while the most commonly used cotton quotation is an average of prices at 10 principal markets in the cotton-growing region, and does not include market-to-mill brokerage and freight costs.

2. Cotton quotations are on a gross-weight basis, with the tare weighing about 4.4 percent, while rayon is sold net weight.

3. The net waste, after allowing for the value of usable waste, is about 10 percent in spinning cotton; not more than 3 percent in spinning rayon staple.

Taking all of these factors into consideration, mills buying Middling 15/16-inch cotton selling for 32.64 cents on a 10-market

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4/ Following the 1948 decision of the Supreme Court on base point prices, some of the rayon producers quoted prices for a time on an f.o.b. no-freight-allowed basis. The largest producer of viscose rayon and the largest producer of acetate rayon, however, continued on a freight-allowed basis.

basis in March 1949, actually paid 38.7 cents 5/ to get as much usable fiber as they could get by purchasing viscose staple for 37 cents per pound, or acetate staple for 42 cents per pound.

Still other considerations are involved in comparing rayon staple and cotton from a price viewpoint. Rayon staple fiber sells for the same price regardless of fiber length, while there are large differences in the price of cotton because of staple length. For instance, in February 1949, mills paid an average of 63.0 cents for 1-1/4-inch cotton, Middling grade, but only 35.01 cents for 13/16-inch cotton of the same grade, per net pound of usable fiber delivered at the mill. Long staple cotton thus was priced much higher and short staple cotton slightly lower than rayon staple at that time.

Cotton prices, of course, also vary considerably according to grade, with average, gross, 10-market quotations during February 1949 for 15/16-inch staple ranging from 15.85 cents per pound for Low Middling Tinged cotton to 32.27 cents for Strict Good Middling White cotton. Allowing for both grade and staple differences, gross, 10-market quotations for American Upland cotton ranged in February 1949 from 12.75 cents to 52.87 cents per pound. There were still other ranges of prices for Indian, Egyptian, Sea Island, and other cottons, with prices for American-Egyptian cottons, for instance, ranging from 31.6 cents to 70.0 cents per pound at El Paso during January 1949.

In contrast to the wide range in cotton prices, there were only slight differences in prices for rayon staple. Viscose staple that is dull or crimped sold for 1 cent more per pound than the regular bright type in April 1949, while a fine, extra-strength type sold for 3 cents more per pound.

The foregoing discussion has indicated some of the qualifications to be kept in mind in comparing prices of cotton and rayon staple on a net, per pound, usable fiber basis. With this as a background, prices of Middling 15/16-inch cotton, viscose rayon staple, and acetate rayon staple are compared in table 1 and figure 1. As indicated, cotton of Middling 15/16-inch grade and staple had a tremendous advantage over rayon in price prior to World War II, but was priced higher than viscose staple from 1945 until the fall of 1948. At that time, because of a decided drop in cotton prices and increases in the price of viscose staple, the two fibers were selling at about the same price. Acetate staple, however, continued to be priced higher than either Middling 15/16-inch cotton or viscose staple, although for some time it has been lower in price than long-staple cotton.

5/ $\frac{(32.64 + 1.77) \times .97}{.956 \times .90} = 38.7$ where 32.64 is the 10-market price for cotton, 1.77 is addition to get mill price, .956 is to allow 4.4 percent tare on cotton, .90 is to allow for 10 percent net waste loss in cotton, and .97 is to allow for 3 percent net waste loss in manufacture of rayon staple.

Table 1.- Comparative prices of cotton, viscose rayon staple, and acetate rayon staple, 1940-1949

	Cotton (M 15/16")		Viscose rayon staple 3/	Acetate rayon staple 4/
	10-market quotation 1/	Price comparable to rayon 2/		
	Cents	Cents	Cents	Cents
Average:				
1940	10.17	12.5	25	43
1945	22.62	26.7	25	38
1946	30.56	35.8	25	44
1947	34.43	40.5	32	48
1948, Jan.	35.15	41.0	36	48
" , Apr.	37.22	43.2	36	48
" , Jul.	34.01	40.0	36	48
" , Oct.	31.21	36.8	37	48
1949, Jan.	32.59	38.4	37	48
" , Mar.	32.64	38.7	37	42

1/ Compiled from reports of Production and Marketing Administration, U. S. Department of Agriculture.
2/ Delivered-at-mill cotton quotations divided by .89 to allow for differences in tare and net waste as compared with rayon.
3/ Bright luster, regular tenacity, all lengths. From Rayon Organon.
4/ All lengths, bright and dull luster, 8 denier or finer. From Rayon Organon.

Comparative Prices of Other Synthetic Staple Fibers

According to price announcements noted in 1948, nylon staple sells for $1.50 per pound, experimental lots of Saran staple for $1.25 per pound, and Vinyon staple for $1.00. The price of Vicara, zein protein staple, was reduced from its introductory price of $1.00 per pound to 83.2 cents per pound in March 1949. All of these fibers thus are priced considerably higher than raw cotton or rayon staple.

PRICES OF CONTINUOUS FILAMENT RAYON YARNS

Trends

At the beginning of rayon production in the United States in 1911, viscose filament yarn (150 denier) sold for $1.85 per pound. Prices rose during World War I, reaching a peak of $6 per pound in 1920, but thereafter a downward trend began, which lasted until about 1934, when the price of 150-denier viscose filament yarn was down to 55 cents. For the next 12 years, or until November 1946, the price remained at about this level, although there were prewar fluctuations between a maximum price of 63 cents in 1937 and an all-time low price of 49 cents in 1938. Since October 1946, however, the price of viscose filament yarns has been increased 4 times, lifting the quotation for the 150-denier

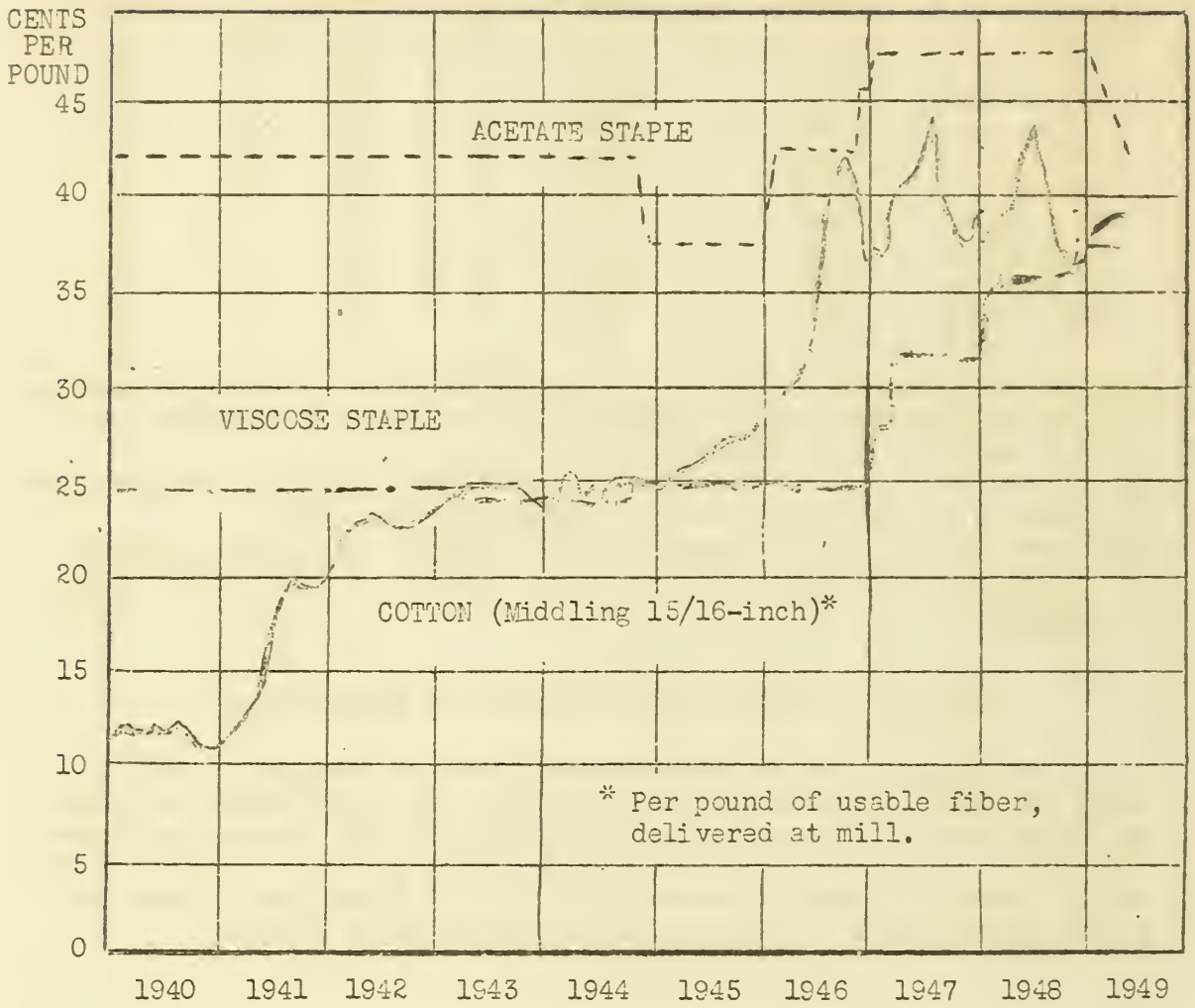

FIGURE 1.- COMPARATIVE PRICES OF MIDDLING 15/16-INCH COTTON, VISCOSE RAYON STAPLE, AND ACETATE RAYON STAPLE, PER POUND OF USABLE FIBER DELIVERED AT MILL, 1940-1948.

Viscose rayon staple was priced lower than cotton from 1945 until the fall of 1948.

size from 55 cents to 77 cents per pound. The last price increase was in August 1948.

The prices just quoted are for the 150-denier, regular-strength viscose yarn, the size and type used most widely for apparel and household uses. The price of 1100-denier, high-tenacity viscose yarn, a higher-strength type introduced for use in tires just prior to World War II, was 43 cents per pound from 1941 until the fall of 1946. The four price increases since then have lifted the price for this type of rayon yarn to 57 cents per pound for August 1948 and thereafter.

Acetate filament yarn. Acetate filament yarn did not appear on the market in sizable quantities until about 1925; and at first its price was high, with a quotation of $2.90 per pound for the 150-denier size from 1925 to 1928. As with viscose yarns, however, there was a period when the price dropped rapidly, and by 1938 the quotation for the 150-denier size was down to 54 cents. From 1939 through October 1946, the price for this size of yarn was 56 cents, but since then it has been increased three times, reaching 74 cents after December 1947. Since about 1935, it might be noted, 150-denier acetate yarn has been closely competitive with viscose yarn of the same size, with only slight differences from time to time in the quotations.

Comparative Prices of Cotton Yarns

As indicated by table 2 and figure 2, both carded and combed cotton yarns were substantially lower in price in 1940 than filament rayon yarns. The situation was reversed during World War II, and from 1946 into 1948, cotton yarns generally were higher priced. Reductions in prices of carded cotton yarns in late 1948 and early 1949 brought these yarns down to under the level of filament rayon yarns in the Spring of 1949, but combed cotton yarns continued to be more costly, although by a much narrower margin.

Table 2.- Average prices of selected cotton and rayon yarns, 1940-1949

	Cotton 1/		Viscose Rayon 2/	Acetate rayon 2/
	Carded	Combed		
	Cents	Cents	Cents	Cents
Average:				
1940.....	29	33	53	54
1945.....	51	59	55	56
1946.....	63	70	56	57
1947.....	79	90	68	68
1948, Jan...	86	100	74	74
" , Apr...	88	100	74	74
" , Jul...	86	98	74	74
" , Oct...	76	88	77	74
1949, Jan...	71	83	77	74
" , Mar...	69	80	77	74

1/ 30s single yarns, New York, midmonth quotations. Compiled from New York Journal of Commerce.

2/ Average price for 150-denier (35s) yarns, delivered. Compiled from Rayon Organon.

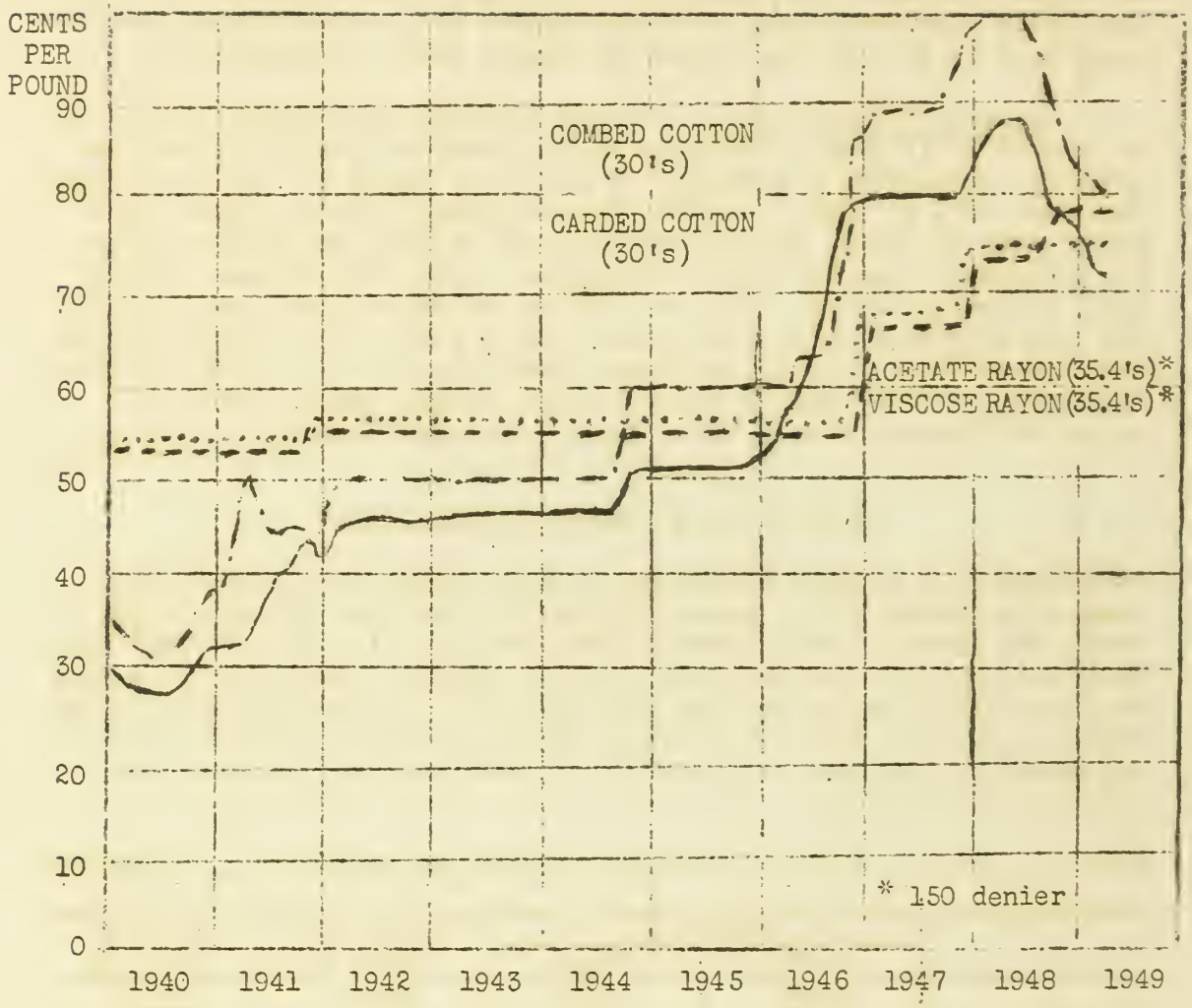

FIGURE 2.- TRENDS IN PRICES OF COTTON YARNS AND CONTINUOUS FILAMENT VISCOSE AND ACETATE RAYON YARNS, 1940-1948.

Cotton yarns were priced much lower than rayon yarns prior to World War II, but were at a disadvantage in price after about 1946.

Rising prices for cotton yarns during the 1940-48 period were due both to increases in cotton prices and mill margins. As indicated in table 3, the cost of cotton for 30s carded cotton yarn climbed from 13 cents in December 1940 to 48 cents in April 1948; then declined to 40 cents in December 1948. Correspondingly, the mill margin (difference between price of cloth and cost of raw cotton) climbed from 20 cents to 38 cents, then declined to 27 cents in March 1949. Similar trends have occurred in prices of combed cotton yarns.

Table 3.- Price, cotton cost, and mill margin, for carded and combed 30s single cotton yarn, at various dates--1940, 1946, 1948, and 1949

Month	Carded			Combed		
	Price 1/	Cotton cost 2/	Mill margin 4/	Price 1/	Cotton cost 3/	Mill margin 4/
	Cents	Cents	Cents	Cents	Cents	Cents
1940, December	32.5	12.9	19.6	37.0	14.7	22.3
1946, October	77.0	44.2	32.8	85.0	49.3	35.7
1948, April	86.0	48.1	37.9	100.0	54.1	45.9
1948, December	74.0	40.4	33.6	83.0	45.2	37.8
1949, March	69.0	41.3	37.7	80.0	46.1	33.9

1/ Midmonth quotations, New York. From New York Journal of Commerce.
2/ Based on using M 1-1/32" cotton, Memphis territory growths, allowing 4.4 percent for tare, and 10 percent for net waste. Quotations from Production and Marketing Administration, U. S. Department of Agriculture.
3/ Based on using M 1-1/16" cotton, Memphis territory growths, allowing 4.4 percent for tare, and 19 percent for net waste. Quotations from Production and Marketing Administration, U. S. Department of Agriculture.
4/ Price less cotton cost.

With both rayon and cotton yarns, the finer the yarn the higher the price. Comparative prices of various sizes of rayon and cotton filament yarns during March 1949 are shown in table 4. As indicated, carded cotton yarns are priced lower than rayon filament yarns in the various sizes, but combed cotton yarns are substantially higher.

It is interesting to note, in this connection, that viscose filament yarns are lower in price than acetate filament yarns in the coarser sizes, but higher in price in the finer sizes. This situation reflects the fact that (1) costs prior to spinning are relatively less for the viscose process than for the acetate process, but the reverse is true for after-spinning steps; and (2) that costs prior to spinning are about the same regardless of the size of yarn being made but after spinning they vary directly with fineness of the yarn.

Price increases since October 1946 have been much greater, in cents per pound, for fine rayon yarns than for coarse ones. The price of the coarse 300-denier size of viscose yarn was increased only 13 cents per pound, while the price of the very fine 50-denier viscose size climbed 38 cents. With acetate yarns, the price of the 300-denier

Table 4.- Comparative prices per pound of carded and combed cotton yarns and viscose and acetate continuous rayon yarns, United States, March 1949

Yarn count	Cotton 1/		Rayon 2/		Rayon yarn	
	Carded	Combed	Viscose yarn	Acetate yarn	Denier and equivalent cotton count	
	Cents	Cents	Cents	Cents	Denier	(Count)
12s	53		58	70	450	(11.8s)
20s	60	72	62	70	300	(17.7s)
26s	65	77	71	74	200	(26.6s)
36s	-	89	77	74	150	(35.4s)
40s	-	93	85	83 3/	125	(42.5s)
50s	-	1.05	97	91 4/	100	(53.1s)
70s	-	1.35 5/	1.10	98	75	(81.8s)

1/ Prices in New York and Philadelphia markets as given in Daily News Record, March 15, 1949.
2/ For cones. Compiled from Rayon Organon, November 1948.
3/ 120 denier (44.3s) for acetate.
4/ 55 denier (96.6s) for acetate.
5/ Estimated from quotations for 60s and 80s.

size has been increased 14 cents per pound, while the price of the 45-denier size was raised 23 cents. These increases reflect, no doubt, the fact that labor costs have increased substantially and that such costs are a greater element in the high-yardage-per-pound, fine rayon yarns than they are in the coarser sizes.

Comparative Prices of Other Synthetic Fiber Yarns

Rayon is by far the lowest priced man-made yarn and the only one that is in the price range of cotton yarns. As with rayon and cotton, prices of the various noncellulosic synthetic yarns increase with the fineness. For the 150-denier size, March 1949 quotations were $1.95 for nylon and $3.00 for Saran, as compared with 77 cents for viscose rayon, 74 cents for acetate rayon, and 95 cents for combed cotton. For 160-denier Vinyon, a size slightly heavier than 150-denier, the price was $1.75. Experimental Orlon yarns, Dupont's newest synthetic fiber, were selling for $3.25 in the 100-denier size and $2.85 in the 200-denier size.

COMPARATIVE PRICES OF RAYON AND COTTON MANUFACTURED PRODUCTS

Accurate comparisons of prices between rayon and cotton products for the consumer are practically impossible because of variations in specifications. In general, rayon fabrics and clothing and household goods have sold for higher prices than similar cotton products; but there are many exceptions to this rule. It should be remembered, in this connection, that many rayon goods are style and luxury items, while most cotton products are of the utilitarian type. Prices of cotton fabrics declined steadily and drastically during 1948 and were followed

late in the year by reductions in prices of rayon fabrics.

The fact that rayon fabrics have been selling at higher levels than cotton goods, while prices for rayon staple and filament yarns have been as low or lower than for raw cotton and cotton yarns, raises a question as to the comparative costs of weaving or knitting rayon and cotton fabrics, and of finishing and converting them into end products. In general, it costs slightly more to weave or knit rayon than cotton because greater care is required, although processing speeds are about the same. Rayon, however, can be knitted on recently developed, high-speed tricot knitting machines at greater speeds than can cotton. Rayon fabrics do not need the intensive bleaching treatments frequently given cotton fabrics to remove impurities, but generally require more careful handling in dyeing and finishing. There is probably little net difference in cost, generally speaking, for this step in textile processing.

It is a widespread opinion that, except possibly during the 1947-48 period, profit margins in manufacturing rayon goods have been higher than those in manufacturing cotton goods, although no statistics can be cited to prove it. Rayon has been a relatively new material and those who processed it have been free to some extent of the usual rigors of textile competition. During the past few years, the supply of rayon staple and filament yarn has been insufficient for the number of mills that wanted to use it. As supply shortages are overcome and more mills enter the field, competition can be expected to become more intense with consequent declines in profit margins. This trend, however, will result in lower prices for rayon textiles.

Tire Fabrics

Rayon's price position in tire fabric is of particular interest to the cotton industry because tire fabric is the largest single end-use of cotton, taking 752,000 bales in 1948. Rayon's percentage of the tire fabric market increased from 3 percent in 1939 to slightly over 50 percent (including a very small amount of nylon) during the fourth quarter of 1948, while cotton's was declining from 97 percent to slightly under 50 percent (table 5).

Prices paid on two dates 6 months apart by independent rubber companies for rayon and cotton tire fabrics are given in table 6. Prices per square yard are said to afford a "substantially correct" way of comparing cotton and rayon costs, except in large tires for highway use, where fewer plies of rayon fabric than of cotton fabric are used. As indicated, rayon fabrics have a decided advantage in price. Although comparable data for earlier years are not available, cotton tire fabrics were cheaper than rayon per pound at the end of the war.

Most tires are made by the four large tire companies, who have their own cotton mills and who manufacture the bulk of the cotton tire fabric they use, instead of purchasing it as do the independents. These concerns undoubtedly move cotton tire fabric to their tire plants at somewhat lower costs than the quotations given in table 6. At the same time, they probably are able to effect some savings over the rayon quotations shown, since they twist and weave purchased rayon yarn into most of the rayon tire fabric they use. Rayon tire fabrics, nevertheless,

Table 5.- Production of cotton and rayon tire cord and fabric in the United States, 1939-1948

Year	Quantities			Percentages		
	Rayon	Cotton	Total	Rayon	Cotton	Total
	Million pounds	Million pounds	Million pounds	Percent	Percent	Percent
1939	9 1/	260	269	3	97	100
1942	28	223	251	11	89	100
1943	44	238	282	16	84	100
1944	94	265	359	26	74	100
1945	181 2/	282	463	39	61	100
1946	212 2/	311	523	41	59	100
1947	230 2/	345	575	40	60	100
1948	249 2/	307	556	45	55	100
3rd quarter	64	76	140	46	54	100
4th quarter	65	64	129	50	50	100

1/ Shipments of rayon yarn to tire manufacturers. From Rayon Organon.
2/ Includes small quantity of nylon.
Compiled from "Facts for Industry," Bureau of the Census.

appeared to be lower in cost than cotton tire fabrics for these concerns in March 1949. At this time the tire industry was consuming all the rayon tire fabric that was being made available to it; but this quantity was far insufficient for the industry's needs and, consequently, cotton fabric still was being used in large quantities.

Table 6.- Prices of rayon and cotton tire fabrics, July 1, 1948 and March 1, 1949

Fabric	Cord construction	Fabric weight per sq. yd.	Price per pound		Price per sq. yd.	
			July 1	March 1	July 1	March 1
		Pounds	Cents	Cents	Cents	Cents
Passenger car tires:						
Rayon fabric.....	1650/2	.67	64	68.5	43	45
Cotton fabric....	12/4/2	.86	76	72	65	62
Truck tires:						
Rayon fabric.....	1100/2	.54	67	69	36	37
Rayon fabric.....	2200/2	.81	63	65	51	53
Cotton fabric....	12/4/2	.86	1/	1/	1/	1/

1/ No quotations.
Based on reports from independent rubber companies for fabric constructions most heavily used.

FUTURE RAYON PRICES

Factors to be Considered

As already indicated, rayon prices remained unchanged for several years, ending with 1946, while the price of cotton was climbing rapidly, with the result that cotton's prewar advantage in price was wiped out. Rayon prices were increased from two to four times, depending on the type, between 1946 and 1948, but were still generally below cotton prices until the cotton price drop in the Fall of 1948 brought them down to about the same level.

How rayon will be priced in the future will depend in part on national and world economic conditions, as well as on such factors as profits made from rayon, manufacturing costs involved, changing technology, and intensity of competition both with other fibers and within the rayon industry. These factors are discussed from the viewpoint of their bearing on future rayon prices.

Profits in rayon manufacture. The following excerpt from "Production Studies of Synthetic Fibers and Paper" (page 416) indicates some of the considerations affecting the relationship between rayon profits and rayon prices:

> "Rayon manufacturers, like other private enterprises, are in business to make money. They are interested in selling at a price that will result in maximum profits in the long run. If they set prices at relatively high levels, they may make a large profit on each pound of rayon sold, but sales may be so limited by the high prices that total profits will be small. Then, too, high prices and wide profit margins often attract new competitors into the business, or might stimulate imports from foreign countries. On the other hand, if rayon is sold at too low a price, profits will suffer. As an extreme example, rayon manufacturers would make no profit at all if their price were set at a level just equal to costs, no matter how much rayon they were able to sell at such a price.
>
> "Since the total profit is the arithmetical product of profit per pound multiplied by sales, it is obvious that rayon manufacturers, like producers of other goods, seek to sell rayon at the particular price level where this total will be at a maximum."

Estimated profit per pound from the manufacture of various types of rayon in 1940 and in 1945-48 are given in table 7. In using these estimates, it should be kept in mind that it has been assumed that profits per dollar of sales on the products shown were equal to the average profit on all sales of the company concerned. Since rayon constitutes most or all of the business of the companies involved, it is believed that this procedure has led to estimates that are fairly accurate but not absolutely so.

Table 7.- Price, estimated cost before taxes, and estimated profit before and after taxes, for viscose, acetate, and cuprammonium rayon yarn, and viscose rayon staple, 1940 and 1945-48 1/

	Yarn					Staple
	Viscose 150 denier			Acetate 150 den.	Cupra average 2/	Viscose
	Company A	Company B	Company D	Company E	Company F	Company A
	Cents	Cents	Cents	Cents	Cents	Cents
1940						
Price	53	53	53	54	75	25
Cost before taxes	48.1	40.1	42.4	41.3	58.4	18.8
Profit before taxes	4.9	12.9	10.6	12.7	16.6	6.2
Profit after taxes	3.6	8.3	8.5	7.7	10.9	4.5
1945						
Price	55	55	55	56	88	25
Cost before taxes	46.6	44.0	43.0	45.6	64.8	21.2
Profit before taxes 3/	8.4	11.0	12.0	10.4	23.2	3.8
Profit after taxes	2.4	3.5	3.8	4.1	8.8	1.1
1946						
Price	56	56	56	57	95	25
Cost before taxes	47.8	43.7	37.2	45.3	72.3	21.3
Profit before taxes	8.2	12.3	18.8	11.7	22.7	3.7
Profit after taxes	4.8	7.6	11.7	6.8	13.8	2.1
1947						
Price	67	67	67	67	107	32
Cost before taxes	55.1	49.3	42.9	52.2	84.2	26.3
Profit before taxes	11.9	17.7	24.1	14.8	22.8	5.7
Profit after taxes	6.1	10.9	15.1	8.9	13.9	2.9
1948 (January - September)						
Price	74	74	74	74	113	36
Cost before taxes	55.9	57.5	47.0	52.7	95.5	27.2
Profit before taxes	18.1	16.5	27.0	21.3	17.5	8.8
Profit after taxes	10.0	10.1	16.4	12.9	10.6	4.9

1/ Profit per pound estimated by dividing total profit by total sales of each company and multiplying by price of designated product except for Company A for 1940 where separate profit figures for yarn and staple as given in Daily News Record, December 21, 1944, are used. Based on data given in annual reports of companies and in Standard-Poor's Corporation Records.

2/ Average for entire production.

3/ And before provision for special amortization of war facilities, except for Company F.

As indiated, the cost of manufacturing rayon generally has increased since 1945, but price increases have been much greater, with the result that for most rayon types, profits per pound have increased very substantially. These increased profits undoubtedly are needed, to at least some extent, because of the greatly increased cost of rayon plants and machinery as will be discussed later.

Certain conclusions regarding how much the price of rayon could be reduced can be reached on the basis of these data on profits. If the price of 150-denier viscose yarn, now 77 cents a pound, were cut from 8 to 14 cents per pound, profits of the various companies would be cut somewhere around half. A reduction of 10 cents in the price of acetate yarn and one of 4 cents in the price of viscose staple would result in similar drastic cuts in profits made from manufacturing these products. It thus appeared that the ability of rayon companies to make reductions in the price of rayon, on the basis of operations at the beginning of 1949, was definitely limited.

Cost of raw materials. One of the principal causes of stability in rayon prices has been stability in the cost of raw materials used in manufacture. According to reports from one large concern, between 1937 and 1945 the total cost of the principal raw materials used in producing viscose rayon ranged between 8.6 cents (1940) and 10.2 cents (1938), a total variation of 1.6 cents. The cost of principal raw materials for acetate rayon declined from 17.4 cents in 1937 to 12.1 cents in 1939, then climbed to 16.1 cents in 1944, and declined to 14.4 cents in 1945.

Since 1945, the cost of raw materials for rayon has increased very substantially. In January 1949, the cost of the principal raw materials for viscose rayon was reported to total 14.7 cents, as compared with 9.4 cents in 1945, while the raw material cost for acetate rayon was reported to total 21.4 cents, as compared with 14.4 cents in 1945 (tables 8 and 9). These increases have been one of the most important factors leading to increased postwar prices for rayon.

The cost of cellulose is by far the most important element in the cost of raw materials for viscose rayon and is the second most costly raw material used for acetate rayon. Rayon manufacturers use special, highly purified grades of wood pulp, and cotton linters pulp derived from the linters left on the cottonseed after cotton is ginned, as sources of this material. They have used wood pulp in preference to linters pulp wherever possible because it usually was cheaper. In 1948, however, they still were using linters pulp to some extent for acetate rayon and to some extent for high-tenacity viscose tire yarn.

The cost of wood pulp increased very substantially between 1945 and 1949, and indications are that it will continue to be high. The increasing demand for cellulose for paper, rayon, and other uses is making it necessary to seek timber supplies farther and farther away from points of use, and to use less desirable species. Because of shortages of dissolving wood pulp in the United States and eastern Canada, one large rayon company is now constructing a dissolving wood pulp plant at Prince Rupert, in northern British Columbia, while another one is contemplating building a plant in Alaska. Wood pulp from these sources will require, it appears, higher freight charges than any yet used in domestic rayon

Table 8.- Quantity, price, and cost of principal raw materials used in producing 1 pound of viscose rayon, 1940, 1945-1949 1/

Materials	1940	1945	1946	1947	1948	January 1949
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Quantity used:						
Wood pulp	1.15	1.12	1.12	1.12	1.11	1.12
Caustic soda	.9	.9	.9	.9	.9	.9
Carbon bisulfide	.34	.35	.35	.35	.34	.35
Sulfuric acid	1.4	1.3	1.3	1.3	1.3	1.3
Corn sugar	.19	.13	.13	.13	.08	.09
	Cents	Cents	Cents	Cents	Cents	Cents
Price per pound:						
Wood pulp	3.8	4.8	5.6	7.0	7.7	8.2
Caustic soda	1.7	1.7	1.7	1.9	3.3	2.9
Carbon bisulfide	3.7	3.8	3.8	4.0	4.3	4.4
Sulfuric acid	.6	.5	.5	.5	.7	.8
Corn sugar	3.1	4.0	4.7	6.0	6.7	5.7
	Cents	Cents	Cents	Cents	Cents	Cents
Costs per pound:						
Wood pulp	4.4	5.4	6.3	7.8	8.6	9.1
Caustic soda	1.5	1.5	1.5	1.7	3.0	2.6
Carbon bisulfide	1.3	1.3	1.3	1.4	1.5	1.5
Sulfuric acid	.8	.7	.7	.7	.9	1.0
Corn sugar	.6	.5	.6	.8	.5	.5
TOTAL COST	8.6	9.4	10.4	12.4	14.9	14.7

1/ Based on operations at one plant of a large rayon manufacturing corporation. Other chemicals such as magnesium sulphate, titanium dioxide, bleaching compounds, etc., are used as additions or substitutes, but they do not result in any substantial increase over total costs shown.

Table 9.- Quantity, price, and cost of principal raw materials used in producing 1 pound of acetate rayon, 1940, 1945-1949 1/

Materials	1940	1945	1946	1947	1948	January 1949
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Quantity used:						
Linters pulp	0.6	0.25	0.26	0.25	0.24	0.31
Wood pulp	.1	.45	.44	.45	.45	.39
Acetic anhydride	1.7	1.7	1.7	1.7	1.7	1.7
Less excess acetic acid	1.3	1.3	1.3	1.3	1.3	1.3
Acetone	.2	.13	.13	.13	.14	.12
	Cents	Cents	Cents	Cents	Cents	Cents
Price per pound:						
Linters pulp	6.2	8.7	9.5	16.3	12.3	9.3
Wood pulp	4.6	5.5	6.2	8.0	8.9	9.5
Acetic anhydride	6.3	6.9	6.9	7.8	9.8	10.7
Acetic acid	2.0	2.2	2.2	2.5	3.1	3.4
Acetone	4.6	7.0	6.2	7.0	8.2	8.5
	Cents	Cents	Cents	Cents	Cents	Cents
Cost per pound of rayon						
Linters pulp	3.7	2.2	2.5	4.1	3.0	2.9
Wood pulp	.5	2.5	2.7	3.6	4.0	3.7
Total cellulose	4.2	4.7	5.2	7.7	7.0	6.6
Acetic anhydride	10.7	11.7	11.7	13.3	16.7	18.2
Less value, byproduct acetic acid	2.6	2.9	2.9	3.2	3.4	4.4
Net cost, acetic anhydride	8.1	8.8	8.8	10.1	12.7	13.8
Acetone	.9	.9	.8	.9	1.1	1.0
TOTAL COST	13.2	14.4	14.8	18.7	20.8	21.4

1/ Based on operations at one plant of a large rayon manufacturing corporation. Other chemicals such as sulfuric acid, ethyl acetate, and soda ash are used in minute quantities in acetate rayon manufacture, but do not result in any substantial increase over total costs shown.

plants. Still another concern is going to build a plant to manufacture dissolving wood pulp from hardwoods at Natchez, Mississippi, using a new process. Until now only softwoods, such as spruce, hemlock, and southern pine, have been used for dissolving pulp in the United States.

Another contributing factor to high wood pulp prices has been greatly increased postwar wage rates. Per hour wages in the pulp and paper industry climbed from an average of 62 cents in 1939 to 91 cents in 1945 and to $1.42 in September 1948, while wages in sawmills and logging camps climbed similarly from 48 cents to 79 cents and to $1.16. 6/

The price of linters pulp was driven to peak levels in late 1946 and 1947 as a result of an acute shortage of cellulose but declined again in 1948 to average 1946 levels. From October 1948 through February 1949, the price of linters pulp was 9.35 cents per pound compared with an average of 16.3 cents in 1947 and an average of 9.5 cents in 1946. The late 1948 and early 1949 price was actually lower than the price of acetate grade wood pulp, this unusual situation arising from the large 1948 linters production linked with the desire, nevertheless, of cellulose consumers to maintain their buying position with wood pulp suppliers, feeling that the low price for linters might be only temporary.

Linters pulp can be expected to be priced as high, or higher than dissolving wood pulp in the future because (1) linters are a byproduct of cotton production and will continue to be produced unless the price falls to extremely low levels; (2) the supply is mainly governed by the size of the cotton crop, and is far too small to meet the demands of users for chemical cellulose; and (3) linters pulp is equal to, or superior to, wood pulp as a source of chemical cellulose.

Considerable research has been under way to make cellulose pulp from agricultural wastes such as bagasse and wheat straw. While the technical suitability of such materials has been demonstrated, they have not been used commercially in this country as yet, and they appear to be economically feasible sources of cellulose only if wood pulp prices are at very high levels.

Because of the fact that cellulose is in short supply on a long-term basis, it cannot be expected that there can be much of a decline in prices for wood pulp and linters pulp. Prices, however, might drop slightly in the event of a decided decline in business activity.

Cost of chemicals. In former years, the cost of chemicals used in rayon manufacture tended to remain quite stable; but prices of most of them increased from 1946 to 1949 in response to rising labor costs, record-breaking demands from consuming industries, and the greatly increased cost of building new plants. General business conditions will have some bearing on future price prospects for these chemicals, with slight reductions possible if prices in general decline.

6/ Bureau of Labor Statistics data. Probably higher wages than have yet been paid in these industries will be required for the operations now beginning in British Columbia and Alaska.

A recent technological advance holds promise of reducing the cost of producing carbon bisulphide, one of the principal chemicals used in viscose rayon. Some time will probably be required to put the new process into commercial use, however; and even then it can be expected to have only a slight effect on the cost of making viscose rayon, since carbon bisulphide currently costs only about 1.5 cents per pound of rayon.

Probably the most significant development in raw materials for rayon has to do with acetic anhydride, the principal raw material in acetate rayon manufacture. One of the largest rayon companies has completed a plant since the war in Texas where acetic anhydride, along with many other chemicals, is made from natural gas, at costs reputed to be much lower than for previous processes. The oil industry is now building plants to make motor fuels from natural gas with organic chemicals such as acetic anhydride as byproducts, and it is expected that the impact on the organic chemicals market will be severe. Reductions in the cost of raw materials for making acetate rayon, therefore, loom as a distinct possibility.

Considering the general economic situation and technological trends in 1949 in the rayon and chemical industries, it would seem unlikely that the cost of raw materials used for viscose rayon manufacture would drop more than 2 or 3 cents per pound in the next few years. The situation regarding acetate rayon is much more uncertain, and it might be hazarded that a reduction of as much as 4 or 5 cents in the cost of raw materials for this process might entirely be possible. On the other hand, further increases in general wage rates would tend to maintain raw material costs at 1949 levels or might even cause them to increase slightly.

Fuel and power costs. Census data indicate that average fuel and power costs were about 1.5 cents per pound for the entire production of the "rayon and allied products industry" in 1939. During the war, power costs in manufacturing rayon tire yarns are said to have ranged between 2 and 3 cents per pound. That fuel costs have risen considerably during recent years is indicated by quotations for mine-run, bituminous coal, which climbed from $4.31 per ton in 1939 to $5.36 in 1945 and to $8.40 in November 1948. On the other hand, the cost of purchased electric energy has either remained unchanged or has declined somewhat compared to prewar, with the price index for commercial and industrial sales of electricity at 84 percent for November 1948 compared to 78 for 1945 and 100 for 1939. Considering these increases, fuel and power costs per pound of rayon probably ranged around 3 to 4 cents per pound in January 1949, less small fractions for (1) technological gains in use of fuel and power, and (2) the trend toward products such as tire yarn and staple fiber, which require less fuel and power to manufacture than textile-type, continuous filament yarns.

Wages and salaries. It is hard to measure how much progress the rayon industry has made in increasing its efficiency in use of labor. The problem is complicated by the major changes that have taken place during the last few years in types of rayon produced and in methods of packaging. It is certain, however, that the industry has been making great strides in improving the utilization of labor. One estimate is that it was producing nearly twice as much rayon per man-hour, after making allowances for

changes in types produced, during the first half of 1948 as it was in 1939 (table 10). 7/ On the other hand, wage rates in the industry rose from an average of 64.6 cents per hour in 1939 to an average of $1.41 per hour in December 1948 (table 11). These rising wage costs completely offset the gains in efficiency but, if the productivity indexes are accurate, left the industry with the remarkable achievement of having no greater a wage cost per average pound of product in 1948 than in 1939.

Table 10.- Indexes of rayon labor productivity and unit labor cost, United States, 1939-1948

Year	Production 1/	Wage earners 2/	Man-hours 3/	Output per Wage earner 4/	Output per Man-hour 5/	Payrolls 6/	Unit labor cost 7/
1939	100	100	100	100	100	100	100
1940	122	105	108	113	113	113	93
1941	140	112	116	125	121	131	94
1942	156	110	115	142	136	145	93
1943	158	109	121	145	131	163	103
1944	170	106	120	160	142	168	99
1945	181	108	120	168	151	175	97
1946	195	116	120	168	162	195	100
1947	217	115	120	189	181	227	105
1948, Jan.- Jun.	244	121	126	202	194	252	103

1/ Calculated by multiplying poundage produced each year of 9 size classes of viscose and cupra yarn, 6 classes of acetate yarn, and of viscose staple and acetate staple, as reported in Rayon Organon, by estimated labor cost per pound in 1939, and dividing the aggregate total by the similar total for 1939.
2/ Number of production workers in rayon and allied products industry as reported by Bureau of Labor Statistics, less estimated number engaged in manufacture of nylon, cellophane and allied products, knit goods, woven goods, and tire fabric within the rayon industry.
3/ Wage erners multiplied by average hours worked, as reported by Bureau of Labor Statistics.
4/ Production divided by wage earners.
5/ Production divided by man-hours.
6/ Wage earners multiplied by average weekly wages, as reported by Bureau of Labor Statistics.
7/ Payrolls divided by production.
For further information on this index see Appendix.

According to best available evidence, at the beginning of 1949 it cost about 6 to 10 cents for labor to produce 1 pound of viscose staple fiber, and from 22 to 31 cents per pound for labor to produce 150-denier viscose filament yarn, the exact amount depending on plant and company

7/ See Appendix on Labor Productivity in Rayon Industry.

Table 11.- Average hourly earnings of production workers in the rayon and allied products industry, 1939-1948

Year	Cents	Index 1939 = 100	Year	Cents	Index 1939 = 100
1939	64.6	100	1945	94.4	146
1940	67.6	105	1946	105.8	164
1941	72.9	113	1947	122.6	190
1942	81.9	127	1948, Jan.-Jun.	128.8	199
1943	87.4	135	" ,Sept.	140.0	217
1944	90.5	140	" ,Dec.	141.3	219

Compiled from Monthly Labor Review and from Statistical Abstract of the United States.

efficiency. The labor cost for producing 150-denier acetate filament yarn was probably around 27 cents per pound with a somewhat lower cost at more efficient plants. Despite very substantial increases in wages, the average unit labor cost of producing rayon was only 6 percent greater during January-June 1948 than in 1945, an indication of rapidly increasing efficiency in the industry.

The trend toward increasing efficiency in the use of labor can be expected to continue as present plans to modernize plants and to build new ones are carried out, and as new labor-saving devices are developed and placed in use. Whether or not the rayon industry will find it necessary to make further increases in wages will depend largely on developments outside the industry. Any further increases in wages may be largely offset, as they have been since the end of the war, by rising efficiency. It is unlikely that wage rates in the rayon industry will decline during the next few years, considering that labor in the industry is organized; but if wages remain unchanged, a moderate reduction in labor costs can be expected because of increasing efficiency.

Depreciation, obsolescence, and amortization costs. Before the war, it cost roughly 85 cents to $1 per pound annual capacity to build a viscose rayon yarn plant and about 35 cents per pound for a viscose staple plant. It would cost at least double to build the same facilities today. In 1947, two companies manufacturing only viscose rayon yarn charged 2.2 cents and 1.8 cents depreciation per pound of rayon produced, while another concern manufacturing all types of rayon charged 2.3 cents for regular depreciation plus 1.4 cents extra because of the current high cost of plant and equipment. Considering the increased cost of building plants, it would appear that rayon companies will have to allow about 2 cents more per pound for viscose yarn and slightly less than 1 cent more per pound for viscose staple than formerly to take care of the increasd depreciation cost which would arise from plants being built at present costs.

Rayon companies are striving successfully to lower the capital cost of increased rayon capacity by expanding and rehabilitating existing facilities. In general, construction costs have advanced more rapidly than equipment costs since 1940, making the incentive for such

action obvious. In addition, rayon companies are developing facilities that will produce rayon more rapidly, making it possible to spread amortization and depreciation costs over larger poundages of rayon. These processes also are resulting in lower labor costs and improved product quality.

As stated in "Study of Agricultural and Economic Problems of the Cotton Belt," page 428:

> Over a longer period of time, it can be expected that the trend toward use of more and more efficient equipment in the rayon industry will tend to offset higher capital costs. It has been reported that Industrial Rayon's continuous process for making viscose rayon yarns, which costs no more or slightly less to install than older processes, makes possible a reduction of 50 percent in the labor required in the manufacture of 150-denier viscose yarns and reduces over-all costs between 4 and 5 cents per pound. It also has been reported that prospective improvements will jump productivity of this process by 30 percent. One other American company has a continuous process in commercial production on tire yarn and at least one other company has been issued patents for such a process.
>
> The most efficient present plant for manufacturing viscose staple is reported to have an advantage of about 3 cents per pound over plants of average efficiency. Since this plant was built just before the war, when costs were far lower than at present, it is expected that it will continue to be the lowest-cost plant for some time in the future.
>
> New methods of continuously handling pulp and chemicals prior to spinning the rayon are reported to be in the course of development which would further reduce labor requirements, and would affect the manufacture of all types of rayon. In general, however, no marked reduction in costs of producing viscose staple and acetate rayon as compared with those now prevailing in the most efficient present plants can be expected from advances in technology during the next few years.

Additional reports regarding the development of improved processes for manufacturing rayon, include the following:

From the 1948 annual report of the Industrial Rayon Corporation:

> During the latter part of November, 1948, we purchased a 1200 acre site on the Ohio River near Point Pleasant, West Virginia. This site will be utilized for the erection of a new plant, when we are satisfied that our research work now under way has perfected new features in our continuous process which will result in greater efficiency in operation and the lowering of costs through better methods and short cuts. . . so that our overall picture will warrant us in proceeding with

our expansion program.

Our objective is to build a plant which will be a real advance in the continuous process with a lower capital cost per pound of annual production. It is not an easy task. That is why it is difficult to estimate the time for its completion; but we feel that it is definitely worth waiting for and we are making slow but real progress in our research and experimental work. The continued high cost of construction, as well as the demand for a better and better product, makes this program imperative if economy in our operations is to be preserved.

From the prospectus on American Bemberg Corporation published November 10, 1948 by the Alien Property Custodian:

Although many improvements have been made, the production methods used by American Bemberg are basically the same as those used thirty years ago . . . Although yarn made by this (Cuprammonium) process has certain very desirable qualities for certain end purposes, and consumer preference for certain products made from such yarn has been demonstrated, mechanical problems traceable to the orthodox method of spinning onto reels and the number of subsequent handling operations have rendered the yarn more difficult and more costly to weave or knit than yarns produced by other processes. The process presents certain difficulties which make for non-uniformity of dyeing which in turn has restricted the type of fabrics which may be made from the yarn. Also the cost of the chemicals is high.

In order to reduce these difficulties, and as a result of research since 1944, the technical staff of American Bemberg has developed a continuous spinning process which eliminates all handling of the yarn until it is completely purified and dried. Machines utilizing this new process have been installed to produce approximately 850,000 pounds of yarn per annum . . . Although the cost of the chemicals is unchanged by the new process, because of the elimination of handling operations the new process results in production costs which are lower than production costs under the old process. The yarn produced by the new process is more uniform and of better physical properties, as a consequence of which difficulties in weaving and knitting such yarn are reduced and dyeing is improved. Tests by American Bemberg and reports received from customers show that the yarn produced by the new process, at normal spinning speeds which have been used to date, is commercially satisfactory, and that such yarn in this respect is an improvement over the yarn produced by the old process. Experimentation looking to increased spinning speeds is now in progress and, if successful, would result in further reduction in costs, as compared with costs under the old process, but the commercial suitability of yarn

produced at substantially higher speeds is still to be tested.

Development of a new continuous spinning process for making viscose rayon yarn for textile industry use by the American Viscose Corproation was announced in the Daily News Record for November 10, 1948:

> Since the new process shortens the time from spinnerette to dried yarn to a matter of a few seconds compared with hours by the pot spinning method and with minutes in other continuous processes, it was indicated the machine would change the entire economic basis of rayon production.
>
> Starting with a new concept of spinning, the new machine which has been developed does not resemble any machine, continuous or otherwise, heretofore used to spin rayon filament yarn. The new machine is smaller, faster, and more efficient than older known machines using continuous methods and is described as far ahead of them.
>
> Assuming a plateau in building and labor costs, it was mentioned that the new machine, because of its high speed, will bring down the cost of viscose rayon filament yarn . . . No new plants will be built, it was declared, but the new process will be installed at one or more of the company's viscose rayon plants . . . Commercial production of yarn by the new process is not expected until January 1951, it was stated . . . Installation of the new process, according to plans, will provide an initial 20-million-pound annual capacity in the new process, which is called the "Filamatic" process.

According to the New York Journal of Commerce for January 11, 1949, annual acetate staple capacity is expected to expand from 72 million pounds in November 1948 to 105 million pounds by July 1949. "This increased output capacity will result from all producers developing technological advances which will accelerate spinning speed plus the completion of the installation of staple fiber equipment in the Celco (Virginia) plant belonging to Celanese Corporation of America . . ."

It appears that the cost of building new rayon facilities will decline somewhat from present levels, considering the above reports, and as the construction and machinery industries return to normal peacetime conditions. Reduction in capital costs can be expected to be moderate, however, except in the case of the new process for manufacturing viscose filament yarn, where apparently very substantial savings are in the offing. Even here, it will take several years before even a substantial percentage of the total production of this type of yarn can be made by the new process. Everything considered, the possibility of capital costs for the entire industry returning to as low a figure per pound as before the war can be ruled out. Technological progress of the industry toward increased efficiency, however, can be expected to continue indefinitely in the future.

Estimated Future Prices

Estimates regarding future prices of any product have been difficult to make since the end of the war. Rayon manufacturing costs rose very substantially during the 1946-48 period, and rayon prices climbed with them. Rising rayon costs were associated with general wage increases and other inflationary influences in the American economy. If wage rates do not climb further, rayon costs will decline moderately and gradually. If they climb further, rayon costs may go still higher. Profits from rayon manufacture in 1948 were at record levels and were large enough to allow some reduction in prices, but a higher level of profits was needed than in preceding years because of the greatly increased cost of building new plants and replacing old ones.

From 1946 through 1948, rayon manufacturers were unable to supply the demand for rayon and were able to sell their product readily at about any price they desired. "Resale" prices for rayon were much higher than manufacturers' list quotations during this period. In the Spring of 1949, however, a buyer's market had at last appeared, and rayon producers were under more pressure from the market to reduce prices than for several years. Rayon yarn and staple fibers were priced from nearly as low to lower than similar cotton items, however, and rayon was in a much more favorable price situation relative to cotton than prewar.

Taking the various factors already discussed into consideration, it appears very likely that rayon prices will not climb further in 1949 and the year immediately following unless there are substantial further wage increases. Otherwise, rayon prices should remain unchanged or decline only slightly in the next year or so. If there were a decline in general business activity, it is unlikely that rayon prices would fall more than about 3 to 5 cents per pound for viscose and acetate staples, 7 to 10 cents per pound for 150-denier viscose and acetate yarns, and around 5 to 7 cents for viscose tire yarn from Spring 1949 prices. In the years ahead, however, there is prospect for a reduced price for textile-type viscose yarn because of the recent development of a new spinning process. 8/

SUMMARY AND CONCLUSIONS

Cotton's most important competitor is rayon. Domestic production of rayon climbed from the equivalent of 1.8 million cotton bales in 1945 to the equivalent of 2.6 million cotton bales in 1948, and further expansion to the equivalent of 2.9 million cotton bales is expected by March 1950. Although consumption of cotton has been at record peacetime levels since the end of World War II, the peak was reached in 1946 and since then consumption has been steadily declining. There is no question that cotton has been replaced by rayon in many important end-use markets during the last few years.

8/ See the new rayon process: Its effect on the industry. American Wool and Cotton Reporter, November 25, 1948, page 27.

A key factor in competition between cotton and rayon is price. Before World War II, cotton was priced much lower than rayon. Cotton rose steadily in price from 1941 until 1946, however, and thereafter until the Fall of 1948, was priced much higher than most types of rayon. As a result of declines then in cotton prices, combined with increases in the price of rayon during 1946-48, cotton was priced from slightly higher to slightly lower than various rayon products in the Spring of 1949.

Rayon staple (rayon cut into short lengths) competes with cotton as a raw material for textile mills. The introduction of rayon staple in the late 1930's gave cotton system mills an alternative, for the first time, to cotton as a raw material. Another type of rayon, comprising most of the production, continuous filament yarn, which is made originally in yarn form, competes with cotton yarns as a material for weaving and knitting. The primary focus of competition, however, between rayon and cotton is after these fibers have been made into end-use products and compete for the consumer's dollar.

Viscose rayon staple was priced at 25 cents a pound from 1937 until 1946 (except for a cut to 24 cents for several months in 1943-44). Since then the price has been stepped up four times, the last increase, in August 1948, raising it to 37 cents a pound. Acetate rayon staple, made by a manufacturing process differing from that used to produce viscose staple and having different properties, sold for 43 cents a pound from 1940-46 (except that some companies cut the price to 38 cents for various periods between October 1944 and April 1946). Two postwar price increases, the last one in January 1947, raised its price to 48 cents a pound, but in March 1948 the price was cut to 42 cents a pound.

Rayon staple is sold on a net, delivered-at-mill basis, and there is a waste loss of not more than 3 percent in spinning it. On the other hand, cotton is sold gross weight, there is a net waste loss of 10 percent in spinning it, and the most widely used cotton quotation, the 10-market average, is for principal markets in the cotton-growing region, and does not include market-to-mill brokerage and freight charges. Taking these differences into consideration, mills buying Middling 15/16-inch cotton selling for 32.64 cents on a 10-market basis in March 1949, actually paid 38.7 cents to get as much usable fiber as they could get by purchasing viscose rayon staple for 37 cents per pound, or acetate rayon staple for 42 cents per pound. On a net, delivered, usable-fiber basis, Middling 15/16-inch cotton was 12.5 cents per pound cheaper than viscose staple in 1940, 10.2 cents higher in 1946, 7.2 cents higher in April 1948, and 1.7 cents higher per pound in March 1949. Prices for rayon staple are the same regardless of length, while long staple cottons are priced much higher than short staple cottons. Long staple cottons thus are at much more of a price disadvantage than are short staples in competition with rayon.

In March 1949, nylon staple sold for $1.50 a pound, zein protein fiber for 83.2 cents a pound, experimental Saran staple fiber for $1.25 a pound, and Vinyon staple for $1.00 a pound. All of these synthetic fibers were priced much higher than either cotton or rayon.

Continuous filament viscose rayon yarn, or simply viscose yarn, sold for 55 cents a pound in the 150-denier size throughout World War II, but four price increases since October 1946 raised the price to 77 cents a pound after August 1948. Acetate yarn has been closely competitive in price with viscose yarn in the 150-denier size since 1935. Three postwar price increases jumped the price of this type of rayon from 56 cents prior to October 1946 to 74 cents after December 1947. Before the war, both carded and combed cotton yarns generally were much lower in price than viscose and acetate yarns, but from 1946 to 1948 were generally higher. Cotton yarn prices dropped substantially in late 1948 and early 1949 because of declines both in cotton prices and mill margins. In March 1949, carded cotton yarns were priced slightly lower than rayon yarns, while combed cotton yarns were slightly higher, although by a declining margin.

Rayon yarn is by far the lowest priced man-made yarn and is the only one within the price range of cotton yarns. For 150-denier size yarns, March 1949 quotations were $1.95 for nylon and $3.00 for Saran, compared with 77 cents for viscose rayon, 74 cents for acetate rayon, and 95 cents for combed cotton. For 160-denier Vinyon, a yarn slightly heavier than the 150-denier size, the price was $1.75. Experimental Orlon yarn, DuPont's new fiber, was selling for $3.25 in the 100-denier size and $2.85 in the 200-denier size; but it was predicted that these prices would decline.

Accurate comparisons of prices between rayon and cotton consumer products are practically impossible to make because of differing specifications, but in general rayon fabrics and clothing and household goods have sold for higher prices than similar cotton products. However, there are many exceptions to this rule. It should be mentioned, in this connection, that many rayon goods are luxury items, while most cotton goods are of the utilitarian type.

In cotton's and rayon's principal industrial use, tires, rayon fabrics have had a decided advantage in price over cotton fabrics. Part of this advantage has arisen from the fact that the required carcass strength in tires can be secured from lighter rayon fabrics than from present commercial types of cotton tire fabrics. In January 1949, cotton tire fabrics sold in the open market for 62 cents per square yard compared with 37, 45, and 53 cents per square yard, respectively, for various types of rayon tire fabrics. The large tire companies manufacture most of their own tire fabrics and probably were able to save more on open market quotations on cotton than on rayon, but their net cost of using cotton undoubtedly was higher than for rayon. Despite cotton's higher price, it held slightly under 50 percent of the total tire fabric market in the fourth quarter of 1948, as compared with slightly more than 50 percent held by rayon, largely because of lack of rayon capacity to supply a larger portion of the tire industry's requirements.

During January-September 1948, rayon companies made an estimated profit of 16 to 27 cents a pound on 150-denier viscose yarn selling at an average price of 74 cents; 14 to 20 cents per pound on 1100-denier viscose tire yarn selling at 56 cents; 21 cents on 150-denier acetate yarn selling for 74 cents; 18 cents per pound on the entire production of cuprammonium yarn selling at an average price of $1.13 per pound;

and 9 cents per pound on viscose staple selling for 36 cents per pound. (These estimates are based on average profits made by leading rayon companies per dollar of sales.) Rayon profits were at peak levels during 1948 and seemed large enough to allow for moderate reductions in price, but larger profits were needed than ever before because of the greatly increased cost of installing and rehabilitating rayon production facilities.

The cost of raw materials for 1 pound of viscose rayon increased from 8.6 cents in 1940 to 10.4 cents in 1946 and to 14.7 cents in January 1949. For acetate rayon, the cost climbed from 13.2 cents in 1940 to 14.8 cents in 1946 and to 21.4 cents in January 1949. Fuel and power costs, which averaged about 1.5 cents per pound for all rayon produced in 1939, are estimated to have nearly doubled since then. The average hourly wage rate in the rayon industry climbed from 65 cents in 1939 to $1.06 in 1946 and to $1.41 in December 1948, but these increases have been completely offset, for the industry as a whole, by gains in efficiency, a remarkable achievement.

Before World War II, it cost roughly 85 cents to $1 per pound of annual capacity to build a viscose yarn plant and about 35 cents per pound for a viscose staple plant, but the same facilities at the beginning of 1949 cost at least double that amount. The rayon industry, however, is striving successfully to bring down capital costs per pound of rayon by developing facilities that will produce rayon more rapidly. A recently announced process for manufacturing textile-type viscose yarn is reported to shorten the time from spinnerette to dried yarn to "a few seconds compared with hours by the pot spinning method and with minutes in other continuous processes."

Taking all of these factors into consideration, plus a change from a "seller's" to a "buyer's" market taking place at the end of 1948, it appears that rayon prices will not rise further unless there are substantial further wage increases. If wage rates remain unchanged, and if business conditions continue prosperous, rayon prices should remain unchanged or decline slightly in the next year or so. In the event of a decline in business activity, reductions of 10 to 15 percent in rayon prices might be possible. In the years ahead, there is a prospect of a substantial reduction in the price of textile-type viscose yarn because of the recently announced new process.

In deciding at what price to sell cotton, in order to meet competition from rayon, the cotton industry should consider many factors, including the following: (1) Rayon is becoming suitable for more and more end-use markets now supplied by cotton. (2) cotton's former large margin of advantage in price compared to rayon was lost during the war, with rayon staple and yarn priced from slightly lower to only slightly higher than cotton, and with rayon tire fabric having a decided advantage in price; (3) because of its cost structure, it is unlikely that the rayon industry can make more than moderate reductions in price in the next few years, except possibly in the case of textile-type viscose yarn; (4) in some end-use markets such as passenger car tires, there is little quality difference between cotton and rayon, and sales therefore depend upon relative price; whereas in other markets, price differences are overshadowed by quality considerations, and in still others, price

differences may not matter much to the ultimate consumer but may exert considerable influence at mill, converting, and marketing levels; (5) despite rayon's rapidly rising importance, cotton still supplies more textile needs in the United States than all other fibers combined, a superiority built on the fact that it offered consumers a better buy—price and quality considered--than any other fiber.

APPENDIX: LABOR PRODUCTIVITY IN RAYON INDUSTRY

As stated by the Bureau of Labor Statistics in connection with its indexes, the object of a production index is to provide a means of measuring "the relationship between the volume of goods produced and one factor of input—labor time. The indexes do not measure the specific contribution of labor or of capital or of any other factor of production." 9/

Rayon production statistics are given in terms of pounds. These data would provide an excellent basis for measuring trends in labor productivity if the industry, year in and year out, made the same products in the same proportions. It does not. During the last 10 years, an increasing proportion of the output has consisted of staple fiber and of high-denier tire yarns, products which require much less labor to produce than fine-denier textile yarns, which formerly comprised the bulk of the production.

Poundage of rayon produced in the United States, in terms of 1939 poundage equalling 100, and four indexes of production in the rayon industry, are given in table 12. Each of the four indexes represent an effort to measure total production of rayon during indicated years in terms of the 1939 output, despite changing types. The old B. L. S. index was based on poundage produced of 4 different product classes weighted by average prices per pound in 1929.

Table 12.- Indexes of rayon production in the United States, 1939-1948

Year	Pounds produced 1/	B.L.S. index: old 2/	B.L.S. index: new 3/	Rayon Organon: index 4/	New index 5/
1939	100	100	100	100	100
1940	124	122	125	121	122
1941	151	144	153	137	140
1942	166	158	171	152	156
1943	174	162	179	148	158
1944	191	175	196	149	170
1945	208	189	212	150	181
1946	225		228	160	195
1947	257		258	179	217
1948					
Jan.-Jun. at annual rate	288				244

1/ Based on pounds produced as reported by Rayon Organon.
2/ Based on poundage production of 4 types of rayon.
3/ Based on poundage produced of 6-denier groups of acetate yarns, 7 of viscose yarn, and staple fiber weighted with 1939 net values, and combined on basis of total man-hours with nylon output.
4/ Based on yardage produced. See text.
5/ Based on poundage of various sizes, etc., produced weighted by estimated 1939 labor cost.

9/ Productivity in the rayon and allied products industry, Bureau of Labor Statistics, U. S. Department of Labor, December 1948.

The new B. L. S. index is based on the same principle but with more product classes and weighted by 1939 unit values, and with additions for nylon as indicated by the following:

> The production index is comprised of two segments. The first, for 1939-40, reflects the trend for rayon output; the 1940-47 segment is a harmonic mean of indexes for rayon and nylon, weighted with estimates of total man-hours required for each product class in each year 1940-47. The index for the rayon component was constructed from production data for 6 denier groups of acetate yarn—87 denier and less, 88-112 denier, 113-137 denier, 138-162 denier, 163-374 denier, and 375-999 denier; for 7 denier groups of viscose and curpammonium yarns (the 6 denier groups listed for acetate plus yarns of 1000 denier and over); and rayon staple fiber, each weighted with 1939 unit values. The production data for rayon are compiled by the Textile Economics Bureau and are published in Rayon Organon. The nylon production index is prepared from confidential data for total yarn and staple fiber production. 9/

The old B. L. S. index met objection on the basis that use of the pound instead of the yard as a means of measuring productivity is unrealistic, and also that "it is difficult to understand how a weighting factor which represents the 1929 average price for rayon yarn and staple fiber can be construed to reflect labor productivity either then or today." 10/ Another criticism was that the rayon and allied products industry is producing more and more products other than rayon, including sheets, sausage casings, tire cord and fabric, and woven, knitted, and finished fabrics. Because of this trend, an index based on rayon production only would minimize output in relation to employment. 11/

The Textile Economics Bureau published another index of production of the rayon industry in the Rayon Organon for September 1946. In this index, "the annual poundage production of viscose plus cupra and acetate yarn each year is divided by the respective annual average denier of yarn spun and multiplied by a 'standard denier'," which is 150-denier for the viscose and cuprammonium yarn processes and 100-denier for the acetate yarn process. "In this way the production of rayon filament yarn is shown on a yardage basis or at a constant denier." Staple fiber is added by dividing the poundage output by one-third, on the assumption that about one-third as many man-hours are required per pound of staple fiber as for 1 pound of filament yarn.

The above index is based on the assumption that "the man-hours of labor expended per pound of yarn are inversely proportional to the yarn denier spun." 10/ This has been objected to on the grounds that it is

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10/ Rayon Organon 17, September 1946, page 146.

11/ Manuscript entitled "Measuring Man-hour Output in the Synthetic Yarn Industry," Solomon Barkin, Textile Workers Union of America.

"conceptually wrong as the weights are derived from conclusions respecting the relation of yardage and labor requirements, which is the answer we are looking for." 11/

It is not the purpose of this study to pass on the merits of the above and other criticisms of the various indexes of rayon production. It is obvious, however, that it would be very difficult to develop an entirely accurate index.

Another index has been prepared in connection with this report. It is calculated by multiplying production each year of 17 classes of rayon yarn and staple fiber (the classes given in the Rayon Organon) by the estimated labor cost per pound for each class in 1939, letting the cumulative product for 1939 equal 100. The labor cost factors were estimated on the basis of corporation reports, data secured from the industry, and government records, and are believed to be fairly accurate. They are as follows:

	Cents		Cents
Viscose and cupra yarn		Acetate yarn	
50 d. (62 and less)...	35	50 d. (62 and less)...	32
75 d. (63-87).....	29	75 d. (63-87).....	24
100 d. (88-112).....	24	100 d. (88-112).....	20
125 d. (113-137).....	19	120 d. (113-137).....	14
150 d. (138-162).....	13	150 d. (138-162).....	10
200 d. (163-237).....	12	200 d. (163 and over).	10
300 d. (238-374).....	10		
375 d. to 999 d.....	10		
1100 d. (1000 and over)	9		
Viscose staple.....	4	Acetate staple.....	6

The index thus calculated indicates the labor time required for the total rayon output each year if the labor input per pound for each size and type of product remained exactly the same as in 1939. By comparing this index with the industry's actual labor input, an accurate measure is provided of the industry's progress in increasing production relative to labor used.

A second step in determining labor productivity in the rayon industry has to do with the number of wage earners in the industry. Published data on wage earners are for the "rayon and allied products" industry and thus apparently include workers engaged in the manufacture of nylon, cellulose sheets, and other products. In addition, some rayon companies knit, weave, and finish fabrics, or twist and weave tire fabric. No data have been available to this study on the number of employees engaged in these extraneous activities, so estimates have been made on the basis of very limited data. Deductions have been made for these workers as indicated in table 13. It is obvious, in this connection, that development of an entirely accurate index of labor productivity in the rayon industry must await development of more accurate data on this subject.