Economic analysis of California cotton ginning technology

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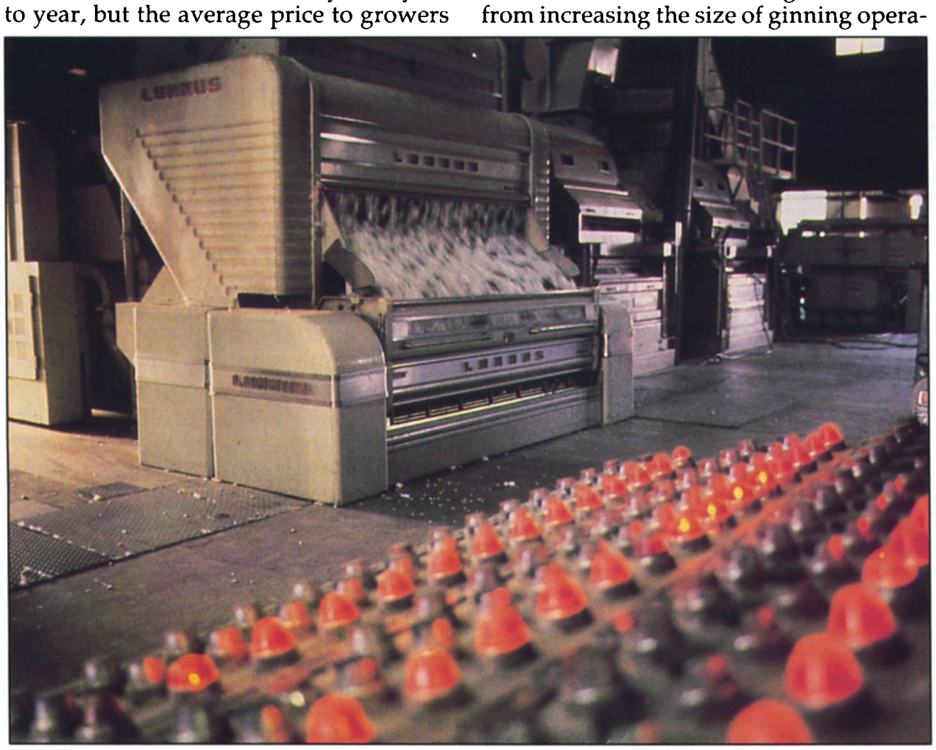
Expanding or merging existing gins could improve their efficiency and profits

Cotton is California's most important field crop and among its five biggest revenue-producing agricultural products. Sales of cotton and cottonseed from the 1986-87 crop were $0.75 billion and amounted to 5% of the state's total agricultural sales. California ranks second only to Texas in cotton production and in the 1986-87 crop year ginned 24% of the U.S. total from nearly a million crop acres. Fresno, Kern, and Kings counties in California annually rank as the nation's three largest cotton-producing counties.

In spite of their impressive production record, California cotton producers have faced a price-cost squeeze in the 1980s. Prices have varied considerably from year to year, but the average price to growers has trended slightly downward over the last 10 years. Increased international competition and unfavorable exchange rates have been the primary causes of poor prices for U.S. cotton. Although U.S. production has been flat, world production has risen 38% in the last decade.

California cotton growers will probably continue to face fluctuating sales revenues because of unstable world markets and the vicissitudes of government programs, but profitability of cotton production could be improved if production and harvesting costs could be reduced. In this article, we analyze the technology of ginning, the largest cost component in cotton production. We estimate the savings obtainable from increasing the size of ginning operations and exploiting lower energy prices during off-peak hours.



Calcot

Larger, more modern ginning equipment helps give California an advantage in throughput and in production of cleaner cotton.

California cotton production

In the San Joaquin Valley, cotton is planted in mid-March. It blossoms in late June, and the plants are defoliated in September before harvest. After picking, the cotton is transported to one of the 146 ginning facilities in the area. Roughly half of these gins are corporate-owned and do custom processing. Nearly a third are cooperatives jointly owned by grower-members. The rest are partnerships and closed corporations that function as vertically integrated facilities for their grower-owners.

The primary purpose of ginning is to separate the cottonseed from the lint. A typical ginning facility has a storage yard, a business office, and the gin structure. The equipment moves the raw cotton through the gin by air flow, dries it with natural gas or propane, removes stems, leaves, dirt, and other trash, separates the lint from the cottonseed, further cleans the lint, and compresses it into 480-pound bales. Gin plant capacities range from 10 to 40 bales per hour. California gins have the largest throughput in the nation, averaging 15,068 bales per year compared with 7,435 bales for the number two state, Arizona. California's throughput advantage is due to a combination of larger, more modern ginning equipment and generally cleaner cotton, which enhances ginning efficiency.

The baled cotton is sold to cotton mills. The seed is sold whole for use in dairy and other livestock feeds or is crushed to produce cottonseed meal and oil.

To explore possible ways to reduce ginning costs, we administered a questionnaire and analyzed financial statements from 22 San Joaquin Valley gins. These provided financial and operations data for the 1980-81 through 1984-85 ginning seasons. All the gins were cooperatives and some operated more than one facility. Our results are thus applicable only to the co-op segment of the California ginning industry, although we are confident that they apply broadly to the entire industry.

We estimated the gross profit for ginning operations by computing revenues obtained from selling baled cotton and cottonseed and subtracting costs for labor, energy, and capital (buildings and equipment). Since cooperatives provide service at cost to their members, the entire amount of the gross profit from these gins flows back to their grower-members.

We developed a statistical model to explain the level of gross profit in terms of the prices paid for variable production inputs (labor, energy, and capital), and the quantity of raw cotton ginned.

Results

Our data encompassed a broad cross-section of the California ginning industry with throughput ranging from 2,900 to 112,000 bales per year—an average of 36,000 bales. Gross profits ranged from $74 to $122 per bale with an average of $95 per bale. Among the variable costs, labor was the highest, taking an average share of profits of 12.1%, followed closely by capital costs with an average profit share of 10.7%. Energy (electricity, natural gas, and/or propane), took an average share of 7.1%.

Economies of size

Of interest to cotton growers and gin operators is the relationship between size of the gins and their efficiency of operation. Do larger operations gin cotton more cheaply than smaller ones? The answer is important when two or more gins are considering merger or when a gin is considering expanding capacity.

Our analysis enabled us to compute the percentage change in profit obtained for each 1% increase in raw cotton processed by the gin. This "elasticity" ranged from a low of 1.08 to a high of 1.12, with an average value of 1.097. This means that economies of size existed throughout the range of our data and tended to increase slightly for larger gins. These figures indicate that a 1% increase in size would raise gross profits by about 1.1%. A 10% increase in size would raise gross profits by about 11% (86¢ per bale); doubling the size would raise gross profits by about 110% ($4.73 per bale).

Although these estimates suggest that larger capacity gins are more efficient, larger gins must draw cotton from a broader geographical area. Transportation costs would increase, lessening the potential gain from larger size.

Our analysis of the cotton ginning industry shows that in some cases the larger gins pay lower prices for some production inputs. One example is the declining-block natural gas rate schedule for gins that are customers of the Pacific Gas and Electric (PG&E) Company. Because larger gins consume more gas in the high-usage, low-price blocks than smaller operations, they pay lower average gas prices. Our economies of size calculations capture only the "physical" economies and not these pecuniary economies.

Time-of-day pricing

Electric utilities in recent years have placed many customers on time-of-day (TOD) rate schedules. These schedules charge customers more for electricity used during periods of peak demand, when expensive secondary fuel sources must often be used to augment primary sources, than is charged during off-peak periods.

Most California cotton gins receive electricity from either PG&E or the Southern California Edison (SCE) Company. Both use TOD rate schedules for most of their gin customers. The gins, however, operate more or less continuously during the ginning season and make no attempt to adapt to the TOD rates.

Because energy, and particularly electricity, is a significant component of the gins' costs, we were interested in the potential savings in taking advantage of TOD rates. We obtained current (February 1988) rate information for the energy used by the gins and computed energy costs for alternative operating schedules.

The schedules were chosen to conform to the key features of the utilities' alternative rates for summer and winter. SCE's winter rates run from October to May, PG&E's from November to April. During the winter, both utilities recognize a 13-hour mid-peak period during weekdays (PG&E, 8:30 a.m. to 9:30 p.m.; SCE, 8:00 a.m. to 9:00 p.m.). All other times are considered off-peak.

In the summer, both utilities have a 6-hour peak period on weekdays from noon to 6:00 p.m. Electricity used during this period is particularly expensive compared with other times. The summertime mid-peak period for PG&E comprises the weekday hours of 8:30 a.m. to noon and 6:00 p.m. to 9:30 p.m., for SCE 8:00 a.m. to noon and 6:00 p.m. to 11:00 p.m. All other times including weekends are defined as off-peak.

TABLE 1. Profit effects of alternative gin operating schedules

Schedule and start-up date	PG&E gins: Change* Energy price	PG&E gins: Change* Labor cost	PG&E gins: Change* Profit	PG&E gins: Change in profit/bale	SCE gins: Change* Energy price	SCE gins: Change* Labor cost	SCE gins: Change* Profit	SCE gins: Change in profit/bale
	%	%	%	$	%	%	%	$
Baseline								
Mid-Sept.	3.81	0.00	−0.25	−0.24	3.85	0.00	−0.30	−0.29
Nov. 1	−4.39	0.00	0.35	0.29	−1.37	0.00	0.10	0.09
Time-of-day								
Mid-Sept.	−13.09	−12.91	2.73	2.44	−12.17	−12.55	2.46	2.32
Mid-Oct.	−14.41	−12.91	2.81	2.53	−12.14	−12.55	2.46	2.32
Nov. 1	−15.41	−12.91	2.90	2.60	−12.59	−12.55	2.50	2.35

* Percentage change relative to baseline with mid-October start-up.

About 99% of the 1986-87 California cotton crop was ginned during October, November, and December, which fall in SCE's winter period but partially in PG&E's summer schedule. If SCE gins start up in September, as sometimes happens, they too incur charges based on the summer rate schedule. These considerations are important, because both utilities use a "demand" charge as well as a charge per kilowatt-hour (kwh) of use. The demand charge is based on the largest use of electricity by the gin during any 15-minute (SCE) or 30-minute (PG&E) interval during the billing period. These demand charges are very expensive during the summer peak period, and any ginning activity during that time immediately incurs a demand charge of several thousand dollars.

To assess the cost savings from alternative time-of-day operating strategies, we needed to consider scheduling operations to conform to off-peak periods and to evaluate the consequences of operating during the utilities' summer months. These considerations suggested the following possibilities:

1. Baseline. Continuous operation 7 days a week, with the ginning season beginning: (a) in mid-September, (b) in mid-October, (c) on November 1.

2. Time of Day (TOD). Operation during off-peak hours only, with the ginning season beginning: (a) in mid-September, (b) in mid-October, (c) on November 1.

The baseline schedule conforms to prevailing practice in the ginning industry. Two 84-hour-per-week labor shifts are used to maintain continuous operation. For the TOD schedules, we assumed a 98-hour work week (two 49-hour shifts). This includes 10 hours of operation per day on weekdays and continuous operation on weekends, all scheduled to coincide with off-peak rates.

To estimate the profit effects of the various alternatives, we first computed the length of the ginning season, based on the number of bales actually ginned by each gin for the 1980-81 to 1984-85 seasons, the gin capacity, and the hours of operation. The TOD schedule would lengthen the ginning season by roughly 42%. Given the estimated length of the season under the baseline and TOD schedules, the season was then located on the calendar by alternatively using the mid-September, mid-October, and November 1 start-up dates.

We calculated an energy price for each situation using current rates for all energy inputs and converting energy prices and quantities to a common BTU base. We derived an overall energy price for each schedule as a BTU-weighted average of the prices for electricity, natural gas, and/or propane. PG&E gas users will have increased costs during a longer ginning season under the TOD schedule, since less gas use will occur each month in the low-cost, high-use blocks. Labor costs, however, will fall because a shorter work week will reduce overtime costs. Our analysis includes the effect of these additional price changes as well as the more obvious changes in electricity costs.

We computed the percentage change in profit for each hypothetical operating schedule, using the baseline schedule with a mid-October start-up as the base value in the percentage change calculations. We calculated the profit effects of the six alternatives for each gin using its estimated length of ginning season for the 1980-81 to 1984-85 crop years (table 1). For the PG&E-supplied gins, mid-September start-up raises energy costs 3.8% on average compared with mid-October start-up, because a greater volume of cotton is ginned under expensive summer peak rates. The loss in profit is about 25¢ per bale.

A November 1 start-up on the baseline schedule reduces energy costs 4.4% on average, relative to mid-October start-up, because all ginning takes place under winter rates. The profit gain is 30¢ per bale.

More substantial savings are achieved under the TOD schedules. Labor cost reductions average 12.9% because of less overtime. Energy savings average from 13.1% to 15.4%, depending on the start-up date. The start-up date is not as important under this schedule, because usage is always in the off-peak period. The profit gains in the TOD schedules range from $2.44 to $2.60 per bale.

A November 1 start-up date for SCE gins produces insignificant savings relative to mid-October start-up under the baseline schedule, because winter rates are in effect in either case. Otherwise, the cost penalty for September start-up and the savings from the TOD schedules for the SCE gins are comparable to those for their PG&E counterparts.

Conclusion

This study of California's cotton ginning industry showed potential economies of size, with each 1% increase in throughput raising gross profits by about 1.1%. These economies suggest possible benefits to expanding or merging gins, which must be weighed in each instance against possibly higher field-to-gin transport costs.

Profit gains ranging up to $2.60 per bale were shown to be attainable for gins that modify operations to conform to utilities' time-of-day pricing schedules. These savings amount to about $8 million, based on the 1987-88 crop, or about $2,600 on average for each of the state's 3,000 cotton growers. These savings, too, must be weighed against possible costs associated with the longer ginning seasons implied by the TOD schedules. The TOD schedules are most realistic for gins that receive cotton in modules allowing for relatively costless on-field storage.

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Weed control in crucifer crops with nitrogen fertilizers

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Only one or two herbicides are available for selective weed control in crucifer crops (broccoli, cabbage, cauliflower, brussels sprouts). With the cancellation of nitrofen, a postemergence herbicide, growers have resorted to hand-weeding of several herbicide-resistant weeds, such as little mallow (*Malva parviflora*), shepherds-purse (*Capsella bursa-pastoris*), and hairy nightshade (*Solanum sarrachoides*).

Hand-weeding costs ($150 to $200 per acre) and the unlikelihood of new herbicides being registered have stimulated research on alternative methods. One possible alternative is the use of liquid nitrogen fertilizers for weed control. These fertilizers have contact-weed-control properties, and crucifers have a protective waxy surface (cuticle) that allows for selectivity.

Experiments were conducted during 1982-87 on broccoli and cauliflower in central California's Salinas Valley to evaluate the effectiveness of liquid fertilizers in killing weeds. The investigation included weed susceptibility, crop tolerance, application technique, volume of application, and the influence of previous pesticide treatments.

Earlier experiments were conducted with shielded-type sprayers to prevent the liquid fertilizers from contacting crop leaves. In later experiments, directed applications with low-pressure nozzles (8002LP) at 15 pounds per square inch (psi) afforded minimal leaf exposure and allowed for applications in 3- to 4-inch bands on either side of the crop plant.

TABLE 1. Weed susceptibility to liquid ammonium nitrate at two stages of growth — summary of 13 field experiments.

Weeds	Control* 1-4-leaf	Control* 5-7-leaf
	%	%
Annual bluegrass	0	0
Barnyardgrass	0	0
Black mustard	92	47
Burning nettle	5	65
Chickweed	97	51
Common groundsel	98	68
Hairy nightshade	96	72
Lambsquarters	0	0
Little mallow	99	77
London rocket	95	54
Nettleleaf goosefoot	0	0
Pineapple weed	98	62
Purslane	0	0
Redroot pigweed	96	58
Shepherds-purse	95	41
Sowthistle	32	0

* Determined from counts of weed per 2 square feet.

Weed control

The band applications along the crucifer row killed emerged weeds. Weeds dried rapidly, allowing for sprinkler irrigation within 48 hours to leach the fertilizer into the root zone.

In studies comparing three forms of nitrogen fertilizers, selectivity was highly consistent with ammonium nitrate (20-0-0) and ammonium thiosulfate (12-0-0-24), but variable with urea/sulfuric acid solutions (15-0-0-16). Additional field experiments were limited to the liquid 20% ammonium nitrate fertilizer.

Rates of 50 to 60 gallons per acre of undiluted 20% ammonium nitrate were effective in killing weeds. Although weed susceptibility varied, results of 13 experiments (summarized in table 1) show that weeds up to the four-leaf stage were more susceptible than larger weeds. Timing the application to control the weeds when smaller usually allowed broccoli or cauliflower plants to reach a suitable treatment size of two to four leaves.