1975

# COSTS OF PRODUCING SUGARCANE IN SAO PAULO, BRAZIL:
## THE POLICY IMPLICATIONS

By
Harlan Hughes & Philip Warnken[1,2]

Sugar production and marketing in Brazil takes place under a complex set of controls governed by the Institute for Sugar and Alcohol (IAA). Backed by federal legislation, the IAA exerts control over sugar production, sugar and sugarcane prices, and domestic and export marketings. The basic control instrument is the annual crop plan (Piano de Safra) issued each April or May. This document specifies:

1) Total sugar production for the forthcoming crop year,

2) Sugar production quotas for mills, and

3) Sugar and sugarcane prices.

In addition, the crop plan reaffirms previous legislation regarding producer-mill relationships. These laws obligate mills to purchase a minimum of 50 percent of the total cane milled from private producers (fornccedores, hereafter called producers) and 60 percent of any additional quota received in any given year from producers. The amount of cane purchased by mills from each sugarcane producer is governed by an individual producer quota based on the average tonage of cane furnished the mill during the preceding three year period.

Rigid controls on prices and supplies of sugar and sugarcane, plus the extensive regulations governing producer-mill relationships, manifest the government's efforts to achieve multifarious policy objectives. One important policy objective is to maintain equity between individual producers and the mills. Both produce sugarcane. For the mill, cane is an intermediate product, but for the individual producer, it is a final product--a cash crop. The consequent interests regarding the prices of cane and manufactured sugar are notably

Paper presented at AAEA annual meeting, Columbus Aug. 10-13, 1975.

different. It is in the economic interest of the mills to maintain low cane prices and high sugar prices in order to maximize profits. Producers, on the other hand, are only concerned with obtaining the highest price possible for their cane.

Brazil's notorious inflation necessitates annual upward adjustments in cane and manufactured sugar prices. Until 1965, producers were the residual claimants of          consumers' expenditures for sugar. New annual prices were established for manufactured sugar and producers received a derived price after deducting manufacturing, processing and other costs. The relationship of this derived price and actual production costs was frequently tenuous at best.

Significant new legislation in December 1965 (Decree Law 4870) resulted in a markedly different approach to the pricing problem. Costs of production—starting at the cane production level on through the milling, manufacturing, processing and marketing system—were to govern pricing policy. Although producer-mill conflict was not mitigated by the legislation, a more rational basis for annual price adjustment was established.

Cost of production studies now provide the basic input for federal price policy decisions for both sugarcane and manufactured sugar. Several interested entities are engaged in these studies including groups representing both producers and millers. These entities present their findings to the IAA before each crop plan and the IAA appears to establish the new prices on the basis of compromise and judgment.

To date, the IAA has not itself become involved in production cost studies. The sugarcane mills through their existing accounting systems and organizations ensure that their costs of production are considered in pricing policy.

Sugarcane producers, for a variety of reasons, have relied heavily on public

research entities for their input into pricing policy. One such entity to which Sao Paulo producers have turned is the Institute of Agricultural Economics (IEA) of the Secretary of Agriculture, State of Sao Paulo. The findings from the IEA annual sugarcane production study represents one of the single most important inputs into federal price policy for the nation's sugar industry.

## RESEARCH OBJECTIVE

The present study was initiated by the IEA in late 1968. The basic objective was a policy objective: to provide the IAA with an accurate estimate of per ton costs of sugarcane grown by Sao Paulo's 9000 plus producers (the 93 existing sugar mills were excluded).[3]

Two other implicit objectives were[4]:

1) To develop a methodology for estimating sugarcane production costs that was both theoretically sound and acceptable to varied interest groups and policy makers.

2) To standardize and computerize this methodology for use in other sugarcane producing regions as well as other agricultural products.

## DATA COLLECTION AND COST CALCULATIONS

Primary data were obtained by surveying 360 sugarcane producers (forne dores only) located in the three major sugarcane producing areas in the state of Sao Paulo. These three regions accounted for approximately 86 percent of all sugarcane produced in the state of Sao Paulo.[5]

Researchers of the IEA visited each of the 360 sample farms during October 1969 to March 1970 and completed a detailed questionnaire covering crop year 1968/69. The completed questionnaires were edited and utilized to estimate costs of production for each sample farm.

## COSTS OF PRODUCTION

Eight variable cost items and five fixed cost items were calculated and summed to arrive at an average total cost of production for each farm. The simple average of all farms' costs of production was used as the sample's average cost of producing sugarcane.[6] A small farm's costs were weighted just as heavy as a large farm's costs.

The average total costs of production for the 360 sample farms was 21.33 cruzeiros per ton (see Table 1). Variable costs averaged 13.02 cruzeiros and fixed costs averaged 8.30 cruzeiros per ton. Total labor costs were divided into two main categories. The first category was the labor utilized for soil preparation, planting, and cultivating of the cane (cost item 1). Since virtually all the cane was cut and loaded by hand, item 4 (cutting and loading) also could be labeled "labor for cutting and loading". Added together, these two labor categories accounted for approximately one-fourth of all costs. Harvesting costs accounted for 22 percent of all costs (category 4 plus 13); interest on operating and investment capital accounted for 28 percent; and depreciation accounted for 12 percent of all costs. Variable costs accounted for 61 percent and fixed costs accounted for 39 percent of the average total costs of production. While the average cost was 21.33 cruzeiros per ton, individual farm costs varied considerably from the sample average as indicated by the median, mode and range presented in Table 1. While it is highly probable that the two extremes of this distribution are due to data errors, there was no economic justification for excluding these farms. A high percentage of the farms were in the 16-24 cruzeiro range with the median in the 19-20 cruzeiro range.

Several statistical methods were used in an attempt to explain the farm to farm variation in average total costs. Simple percentages, simple correlations, weighted correlations,[7] analysis of variance, and stepwise multiple regressions,

## AVERAGE COSTS OF PRODUCTION PER TON FOR THE 360 SUGARCANE FARMS STUDIED
## (1968/69 CROP YEAR)

| | | SIMPLE AVERAGE | |
| --- | --- | --- | --- |
| | Item | Cruzeiros Per Ton | Percent |
| A. | VARIABLE COSTS | (Cr$) | (%) |
| | 1. Labor Excluding Harvest | 2.08 | 9.74 |
| | 2. Fuel, oil, repairs, feed | 1.91 | 8.95 |
| | 3. Seed and Fertilizer | 2.86 | 13.40 |
| | 4. Cutting and Loading | 3.36 | 15.75 |
| | 5. Tractor Rent | 0.15 | 0.73 |
| | 6. Interest on Operating Capital | 1.20 | 5.61 |
| | 7. Transportation | 1.35 | 6.31 |
| | 8. Social Taxes on Labor | 0.12 | 0.58 |
| | TOTAL VARIABLE COSTS | 13.02 | 61.06 |
| B. | FIXED COSTS | | |
| | 1. General Expenses | 0.41 | 1.93 |
| | 2. Interest on Equipment | 1.32 | 6.20 |
| | 3. Interest on Build. Invest. | 0.88 | 4.13 |
| | 4. Depreciation | 3.08 | 14.42 |
| | 5. Interest on Land Invest. | 2.61 | 12.25 |
| | TOTAL FIXED COSTS | 8.30 | 38.94 |
| C. | AVERAGE TOTAL COSTS | 21.33 | 100.00 |
| D. | Median | 19.00-19.90 | |
| E. | Mode | 19.01 | |
| F. | Range | 9.20-74.60 | |

were used. The conclusion was that the major cost items accounting for the variation in total costs were: (1) depreciation, (2) cutting and loading, (3) seed and fertilizer, and (4) interest on land investment. As sugarcane production becomes more modernized, these four cost categories will undoubtedly become even more important.

Further analysis pointed out that 29 percent of the farms, producing 42 percent of the cane sold, had costs below the 17.80 cruzeiro price set by the Government for the 1968/69 crop year. Clearly, Governmental pricing policy is favoring some economic units over others. What size of an economic unit is the Government's present pricing policy actually favoring? Is Government pricing policy encouraging the formation of larger or smaller economic units? The next section will attempt to answer these questions.

## SIZE OF FARM OPERATION AND ITS IMPACT
## ON COSTS OF PRODUCTION

Even though size was not formally considered in the previous analyses, indications were that size of operation did have some effect on production costs. Two approaches to "size" analysis will be discussed. First, the "Lorenz" curve approach and second, statistical cost functions.

The "Lorenz" approach is illustrated in Figure 1. The 360 farms were sorted in ascending order based on average total costs per ton. Since both axes are in percentages, the Lorenz curve represents the percent of the total production produced by the various percent of the farms rank in ascending cost order. Both axes by design must total 100 percent. The diagonal line (having a slope of 1) represents the case where each farm produces the same tonnage. A deviation to the right of the diagonal line implies a cumulative concentration of larger than average farms and a deviation to the left of the diagonal line

implies a cumulative concentration of smaller than average farms. In addition, any time the slope of the line is greater than one, a concentration of smaller than average farms is also indicated. It is important to remember that the lowest cost farms are represented in the lower left-hand section of Figure 3 and that the highest cost farms are represented in the upper right-hand section of the figure.

It was previously pointed out that 29 percent of the sample farms, producing 42 percent of the sugarcane, had costs of production at or below the Government's 1968/69 set price of 17.80 cruzeiros per ton. These percentages are represented by the dashed lines in Figure 1. It is evident from the lower left-hand section of Figure 1 that these farms were generally larger than average. There is, however, one segment of this lower portion of the graph (section ab) where the slope of the curve is greater than one implying a concentration of smaller than average farms. Further study showed that these smaller farms were in the 15-16 cruzeiro cost group; in fact, 15 out of the 19 farms in this group were below average size. Another sharp increase in the slope occurred between points (cd), the 19-20 cruzeiro cost range. Thirty of the 39 farms in this cost range were below average size. A slope greater than one is noticed in other segments of the curve which tends to make one point quite clear. The smaller farms are not concentrated in any one particular segment on the graph; therefore, the small farms are not all low, medium or high cost farms. Low costs are not due simply to large or small farm units.

The 360 sample farms were divided into seven different groups based on their average total costs per ton. The seven groups were: (1) less than 12.00, (2) 12-15.00, (3) 15.01-17.80, (4) 17.81-20.00, (5) 20.01-25.00, (6) 25.01-30.00, and (7) greater than 30 cruzeiros per ton. An analysis of variance was performed with these groups to test the null hypothesis that the average tons of sugarcane produced per farm were equal. If the null hypothesis could not be rejected, the

# FIGURE 1

## CONCENTRATION OF PRODUCTION ON ALL SAMPLE FARMS
## ARRANGED IN ORDER OF INCREASING COSTS
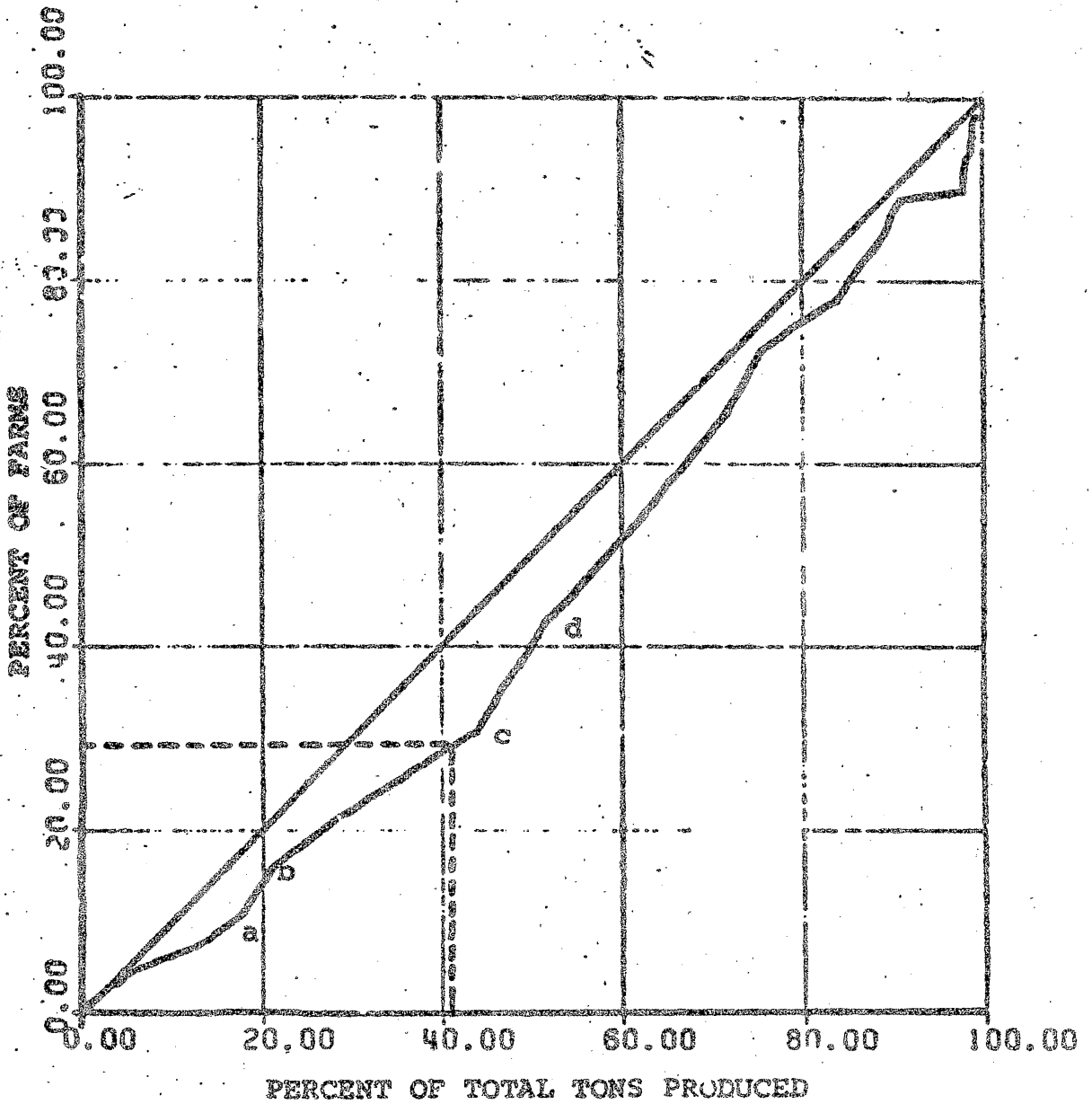
differences among the seven groups must represent mere random variations. Since the null hypothesis that the groups' average tons per farm were equal could not be rejected, the apparent difference between groups represents mere random variations.
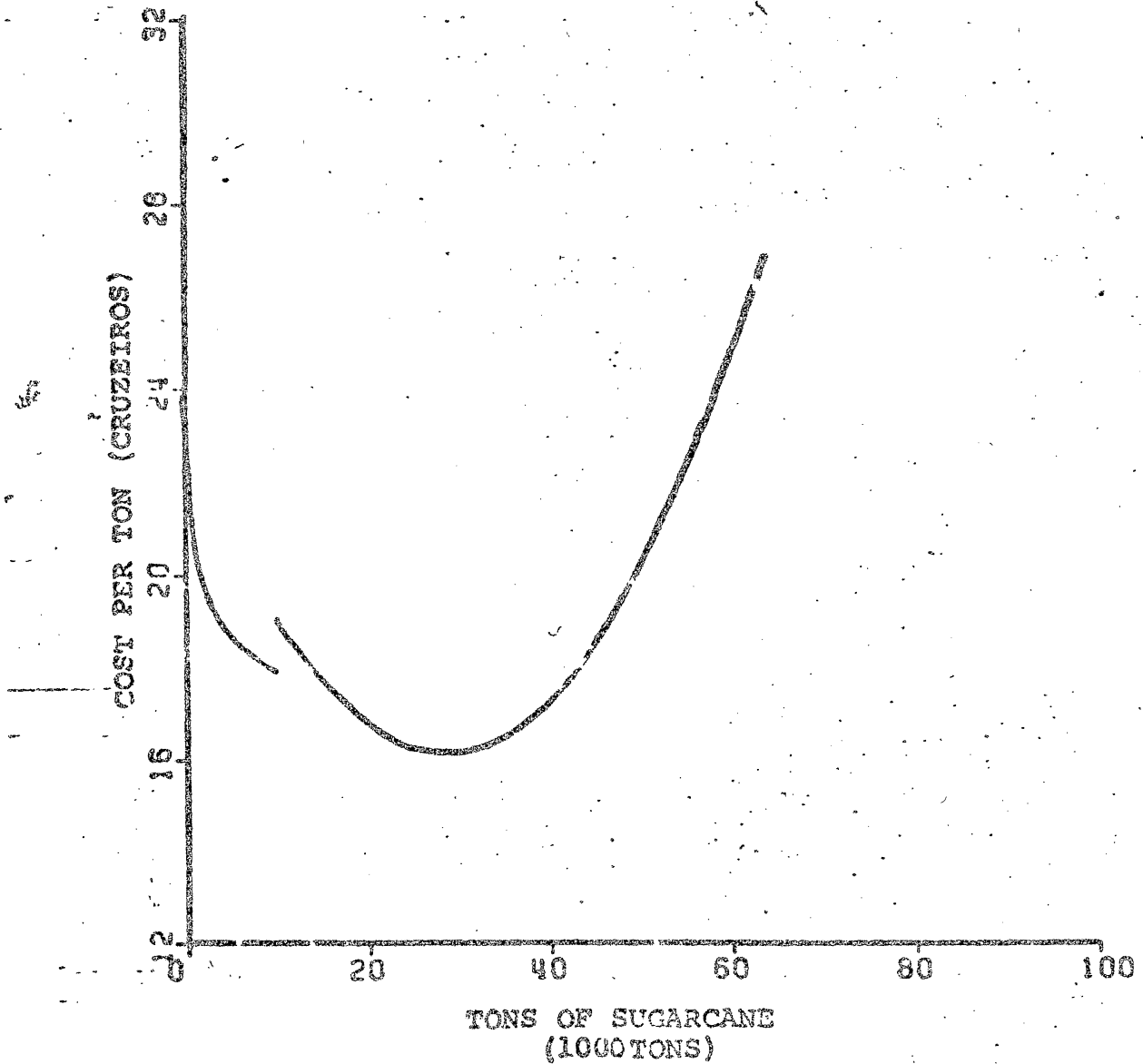
## ECONOMIES AND DISECONOMIES OF SCALE

Statistical long run average total cost functions were estimated for all sample farms. This was considered a long-run analysis because several different production technology levels were represented by all the sample farms and it was assumed that changing to another technology level by an individual farmer was a long-run decision.

Long-run average total costs per ton were best represented by two different cost functions.[8] The first function covered farms producing less than 10,000 tons of sugarcane per farm. The second function covered farms producing from 10,000 tons to 64,000 tons per farm. The two functions are presented in Figure 2.[9]

The average total costs for farms less than 10,000 tons decreased as tons produced increased. Economies of scale were statistically significant and average total costs did decline as tons of cane produced per farm increased. The average total cost curve estimated for those farms producing over 10,000 tons demonstrated economies of scale up to 28,000 tons. At this production level the average total cost per ton equaled a low of 16.40 cruzeiros per ton. Based on Figure 2, farms between 16,000 and 39,000 tons had, on the average, production costs below the Government's established 1968/69 market price.

Caution needs to be exercised when interpreting the estimated long-run average total cost functions. Nevertheless, it is concluded that average total costs decreased up to 28,000 tons per farm. On the average, a farm producing 5000 tons had an average total cost 11 percent below the all sample average, (but still 0.97 cruzeiros above price received). Farms averaging 28,000 tons

# FIGURE 2

## LONG RUN AVERAGE TOTAL COSTS FOR ALL
## SAMPLE FARMS

per farm had an average total cost 23 percent below the all sample average.
Evidence points towards diseconomies of scale beyond 28,000 tons per farm;
however, the relatively small number of observations of large farms precludes
any strong statements about large farms. Since the average farm in the sample
produced only 2914 tons per farm, some economic implications can be drawn
from the larger number of smaller sugarcane farms.

Government pricing policy is favoring the consolidation and formulation
of larger and fewer sugarcane producing farms. The extent to which this growth
will occur over the long run depends primarily on the Government's policy with
respect to the quota system. If tonnage quotas are virtually frozen in their
present form, very little structural change can occur. If on the other hand,
quotas are permitted to change through sales of the quota or some other
institutional mechanism, the average sugarcane farm will become larger and
fewer.

The future number and size of sugarcane producers in the state of Sao
Paulo will depend totally upon the Government's policy toward sugarcane quotas,
sugarcane prices, and the amount of sugarcane a mill has to purchase from
sugarcane producers. Since the Government completely controls sugar produc-
tion through price and quantity controls, the future of the Brazilian sugar
industry rests in the hands of policy makers. Hopefully, this research has
provided policy makers with some insights into cost of producing sugarcane and
its policy implications.

# FOOTNOTES

1. Harlan Hughes is Assistant Professor, Department of Agricultural Economics, University of Wisconsin-Madison; and Philip Warnken is Associate Professor, Department of Agricultural Economics, University of Missouri.

2. Research sponsored by the Ford Foundation and the University of Missouri. Information for this article taken from Economic Analysis of Sugarcane Production In Sao Paulo, Brazil (Fornecedores 1968/69), Ph.D. thesis, University of Missouri, 1971, by Harlan Hughes.

3. According to the Mapa De Fornecedores (Map of Private Producers maintained by the Sugar Institute), there were 9422 private sugarcane producers in Sao Paulo during 1967. There were approximately 93 sugar mills also operating in the state of Sao Paulo.

4. While space does not allow a discussion of the results in this paper, an additional objective was to provide a detailed basis for policy interpretation of the point estimated production cost. This more detailed cost analysis included:

   (1) A stratification analysis of three regional, eight farm sizes, and three technological cost structures.
   (2) Supply function estimates including supply elasticities for the different strata.

5. Source: Estatisticos Agricola IEA, 1968, 1969, 1970.

6. Other average costs were also weighted according to tons of sugarcane produced. The weighted costs are not reported in this paper.

7. The weighted correlations were calculated on total costs (average times tons produced) as contrasted to simple correlations on the average costs. The weighted correlations provide an analysis of all costs weighted by the number of tons produced.

8. Three statistical cost functions were estimated:

   (1) $TC = F(T)$
   (2) $TC = f(T, T^2, T^3)$
   (3) $\log TC = f(\log T)$

   where:

   TC = total cost per farm
   T = tons of sugarcane produced per farm.

   The best equation was selected on statistical values of the $R^2$, the F value, the T value, and the partial correlation coefficients. The functions were also subjected to economic considerations, and when necessary, a compromise was made.

9. The two statistical functions estimated are:

   (1) $TC = 673.5\ T^{-0.061806}$
   (2) $TC = -3071.30 + 2351.33T - 5.018T^2 + 0.00869T^3$ for farms over 10,000 tons.

   where TC = total cost and T = tons of sugarcane per farm.