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The Cost of Maple Sugaring in Vermont

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Abstract

We developed an annual maple-syrup-production cost series for the period 1972 to 1984. We specified the physical input required for a 3,000-tap, plastic tubing with vacuum system with an oil-fired open-pan evaporator. Current value data were used to estimate the annual production cost of a gallon of syrup. Cost increased from 6.16 per gallon in 1972 to $15.93 in 1984; however, much of this increase is the result of inflation. The sugarhouse, where syrup is processed, accounted for a relatively larger share of the total cost of production in 1984 (66 percent) than it did in 1972 (53 percent). A sensitivity analysis indicated that total cost is most sensitive to changes in wages for labor and cost of fuel oil.

Introduction

What does it cost to make a gallon of maple syrup? This question was answered for a few points in time. However, an annual series of syrup production cost had never been developed so that the trend in cost could be studied. Such a series could be used to examine the effects of changing technology and the relationships between major cost areas, such as sap collection and syrup processing, over time. It could be used to assess the potential benefits of new technology by equipment developers, manufacturers, and syrup producers. Financial analyses by syrup producers and lenders supplying capital to the industry could be done more accurately using information from a production cost series. Public policy analysts and planners could use the information to improve their understanding of the industry.

Our objectives were to develop time series of maple production costs and to observe the effects of changing technology, fuel price, interest rate, and sap sugar content on production cost. In addition, the relationships between major production cost items were examined.

The USDA Forest Service reported costs of maple sap production for 1972 to 1973 and the cost of maple syrup production for 1977 (Huyler 1975, Huyler and Garrett 1979). That information was updated in 1980 (Huyler 1982a, Huyler 1982b). These studies specified the relationships between physical inputs, such as labor and equipment, and syrup production.

The production cost index was based on cost data estimated for a 3,000-tap tubing with vacuum operation and an oil-fired evaporator. Cost increased steadily from 1972 through 1981. From 1982 through 1984, the last year in the series, the index stabilized. Costs increased more than 2.5 times from 1972 ($6.16 per gallon) to 1984 ($15.93 per gallon). The farm price for maple syrup almost doubled over the same period, from $9.30 to $17.20 per gallon.

Methods

Obtaining actual costs of maple syrup production even for a small sample of maple syrup operations is difficult. Moreover, unless collected on an annual basis, annual costs are difficult to reconstruct. The highly variable nature of the industry in terms of syrup yield per tap, sugarbush size and layout, and sap collection and syrup processing techniques makes analysis of these data potentially difficult.

An alternative method is to: (1) specify the equipment necessary to produce maple syrup for a commercial size operation; (2) define the relationship between physical inputs of production, such as labor and fuel, and physical outputs, such as sap and syrup; and (3) convert physical units to dollars by applying annual estimates of prices or values of items for which no money need be exchanged, such as volunteer labor.

Huyler (1975) has shown that the tubing with vacuum system is the lowest cost method of sap collection. We chose this system for our production cost trend analysis. For comparison, production costs for the traditional bucket system were also estimated.

Syrup processing in a conventional open-pan evaporator is standard for the industry. The two major fuels are wood and No. 2 fuel oil but natural gas and LP gas are sometimes used. No. 2 fuel oil was compared to wood because price information for these fuels is readily available.

A 3,000-tap operation was selected for analysis. Huyler and Garrett (1979) have shown that this size is large enough to achieve most of the cost economies of larger operations in both average investment and annual operating costs. It is large enough to make a significant contribution to the owner's total income, but not so large as to be more than a supplemental source of income, the typical situation in the maple syrup industry. For comparison, production costs for 2,000- and 4,000-tap operations were also estimated.

Figure 1 shows the process we used to create the maple syrup production cost index. The Appendix contains tables that include standard equipment lists; labor and energy requirements; and sources for property tax, insurance, and price information.

Two factors not considered in the analysis were appreciation of land value accruing to the landowner and income tax. The addition of both items would add unnecessary complexity to the analysis without much benefit. Widely varying land values, due to factors largely external to maple syrup production, would make a statewide average difficult to obtain and questionable.

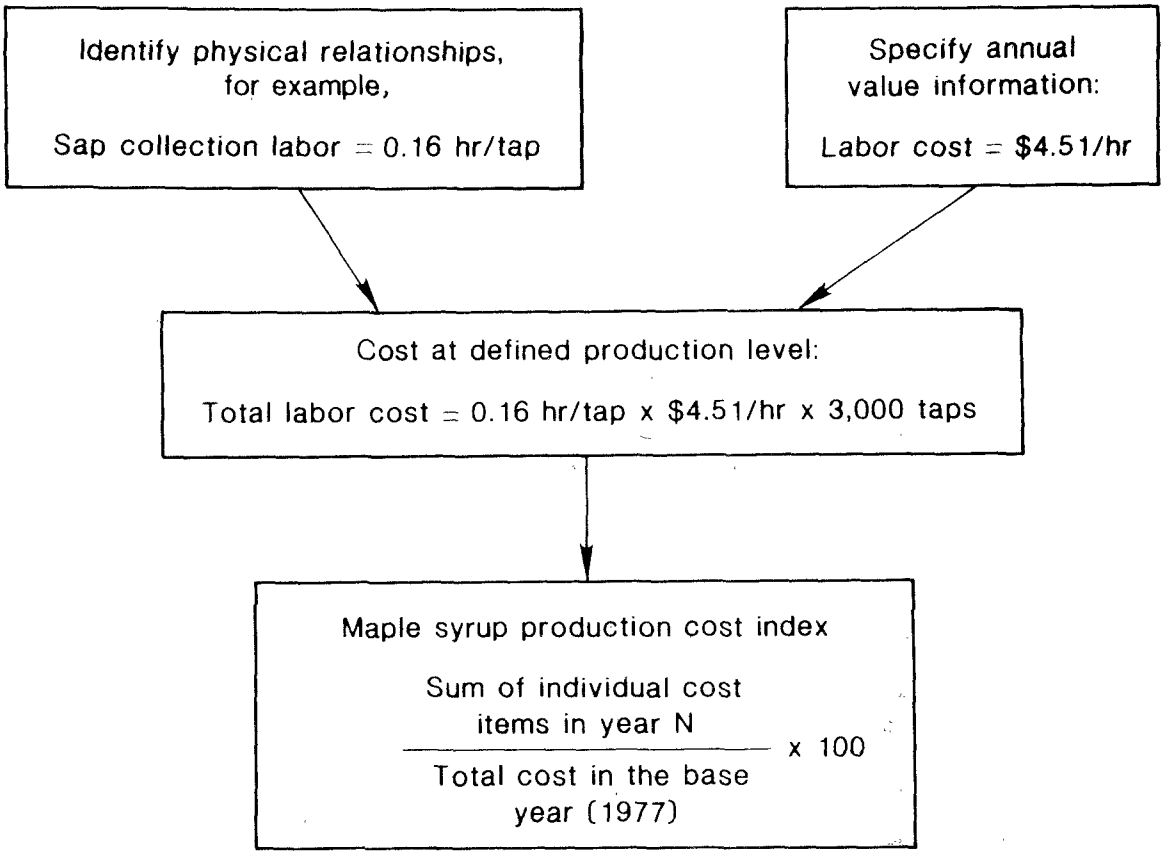


Figure 1.—Schematic of the method used to calculate the maple syrup production cost index.

Results

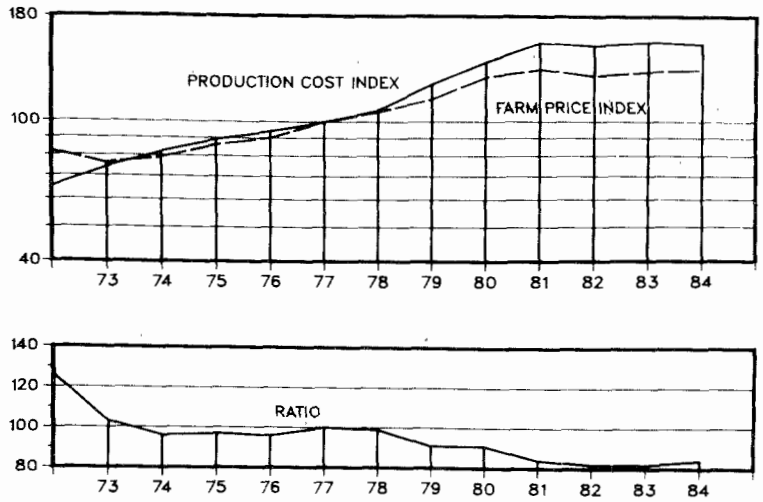
Production Cost Index

Figure 2 shows the annual production cost per gallon of syrup expressed as an index (1977 = 100) for the period 1972 to 1984. This index includes the value of input factors for each year including equipment and building depreciation based on current cost. The cost data were estimated for a 3,000-tap tubing with vacuum operation and an oil-fired evaporator.

Cost increased steadily over the period until 1982, when the index began to stabilize. Major increases in cost occurred in 1979, 1980, and 1981. Cost increased more than 2.5 times from 1972 ($6.16 per gallon) to 1984 ($15.93 per gallon). Much of the increase in cost was inflationary.

The trend in annual maple syrup price is also shown as an index (1977 = 100) in Figure 2. This index is based on price reported by the Statistical Crop Reporting Service for Vermont which is an average price received at the farm for all sales including retail and wholesale (USDA, Stat. Rep. Serv. 1972-84). In 1972, the exceptionally high price was most likely the result of below average production in both the U.S. and Canada in 1971 leading to a world shortage of maple syrup. After 1973, the trend in price was steadily upward until 1982. In 1982, the decline in maple price was most likely the result of above average production in both the U.S. and Canada leading to a world surplus of maple syrup. Price almost doubled from 1973 ($9.30 per gallon) to 1984 ($17.20 per gallon).

Figure 2 also shows the ratio of the maple syrup price index and the production cost index. A value of 100 indicates that the two indexes were equal, that is, prices and production costs changed in the same proportion relative to their



YEAR	COST OF MAPLE SYRUP PRODUCTION	MAPLE SYRUP PRICES RECEIVED BY PRODUCERS	RATIO[a]
	---------INDEX---------		
1972	65	82	126
1973	74	76	103
1974	82	79	96
1975	89	86	97
1976	94	90	96
1977	100	100	100
1978	108	107	99
1979	128	116	91
1980	148	134	91
1981	168	141	84
1982	165	135	82
1983	169	139	82
1984	167[b]	141[b]	84[b]

[a]RATIO OF INDEX OF MAPLE SYRUP PRICES RECEIVED BY PRODUCERS TO INDEX OF COST OF MAPLE SYRUP PRODUCTION

[b]PRELIMINARY ESTIMATE

Figure 2.—Production cost index for maple syrup, maple syrup price index, and ratio of price index to cost index.

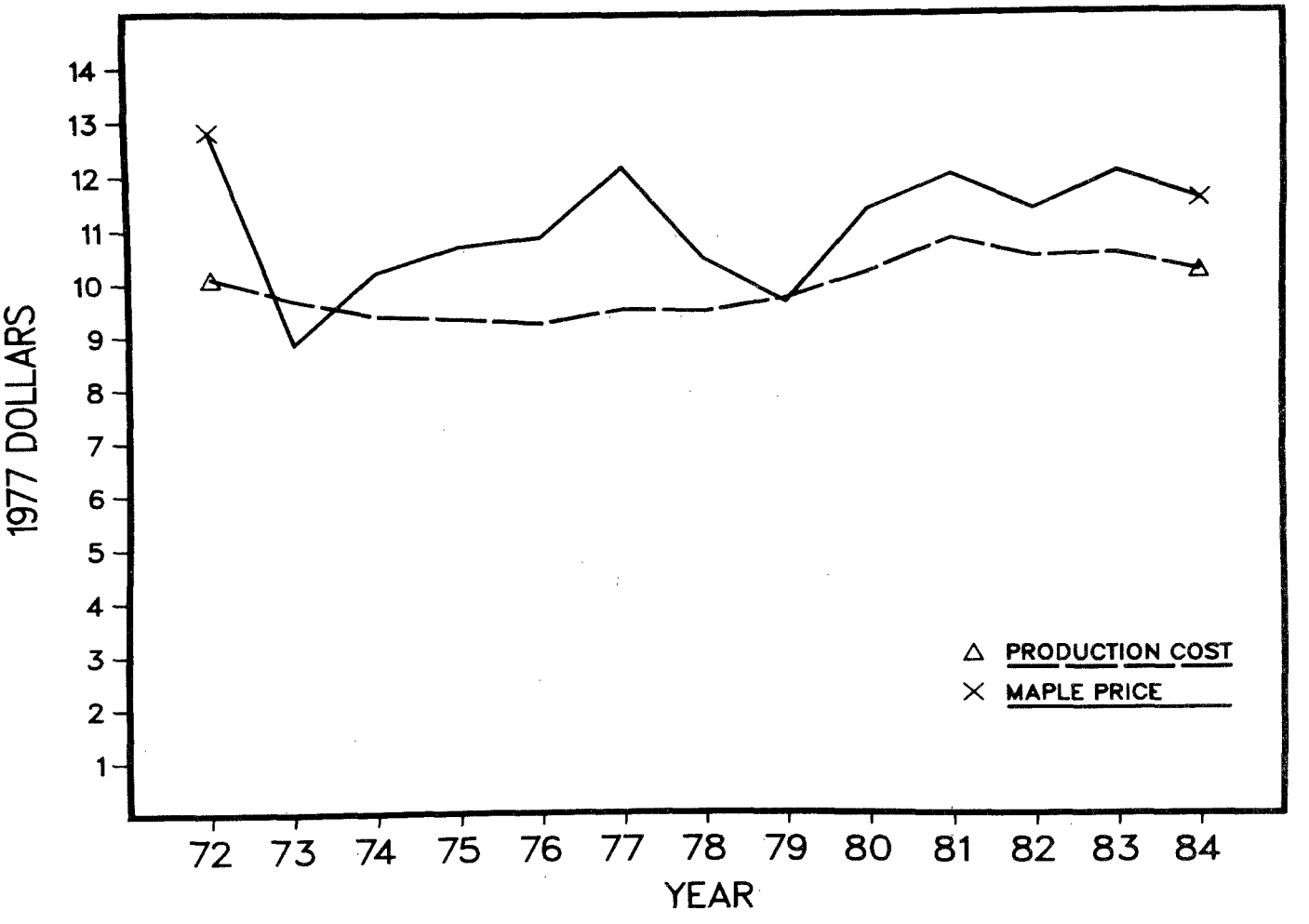


Figure 3.—Product cost and farm price for maple syrup in Vermont in constant (1977) dollars, 1972-84.

respective base year value. The ratio for most years is near 100. However, in 1972, the maple price index was significantly higher than the production cost index yielding a ratio of 126. In 1982 and 1983, the reverse in the upward maple price index trend is reflected in values significantly lower than the production cost index yielding a ratio of 82 for both years. Perhaps this reflects an adjustment toward equilibrium between supply and demand in the maple syrup market after a major change in quantity of syrup produced.

The study period included the worst period of inflation in modern U.S. history. The year to year change in the Consumer Price Index (CPI) exceeded 10 percent for 1979, 1980, and 1981. Only in 2 other years since World War II did the year to year change in the index exceed 10 percent. The change exceeded 5 percent in 16 of the last 39 years (Council of Economic Advisers 1984). To remove the effect of inflation, production costs were adjusted by the Index of prices paid by farmers for production items. Maple syrup prices were adjusted by the Index of prices received by farmers for livestock and products (Council of Economic Advisers, 1972-84).[1] Figure 3 shows the maple production cost and syrup price series in 1977 (constant value) dollars. Measured in constant value dollars, production costs have varied little over the period—only 17 percent from the lowest cost, $9.26 (1976), to the highest, $10.84 (1981). Maple syrup prices showed greater fluctuation over the period—about 45 percent from the lowest price, $8.86 (1973), to the highest, $12.82 (1972). The production cost weighted by annual syrup production averaged $9.97 (1977 dollars) per gallon over the period and weighted syrup prices averaged $11.16 per gallon.

[1] The annual syrup production cost or syrup price was divided by the appropriate index number and the quotient multiplied by 100 to obtain the adjusted cost or price.

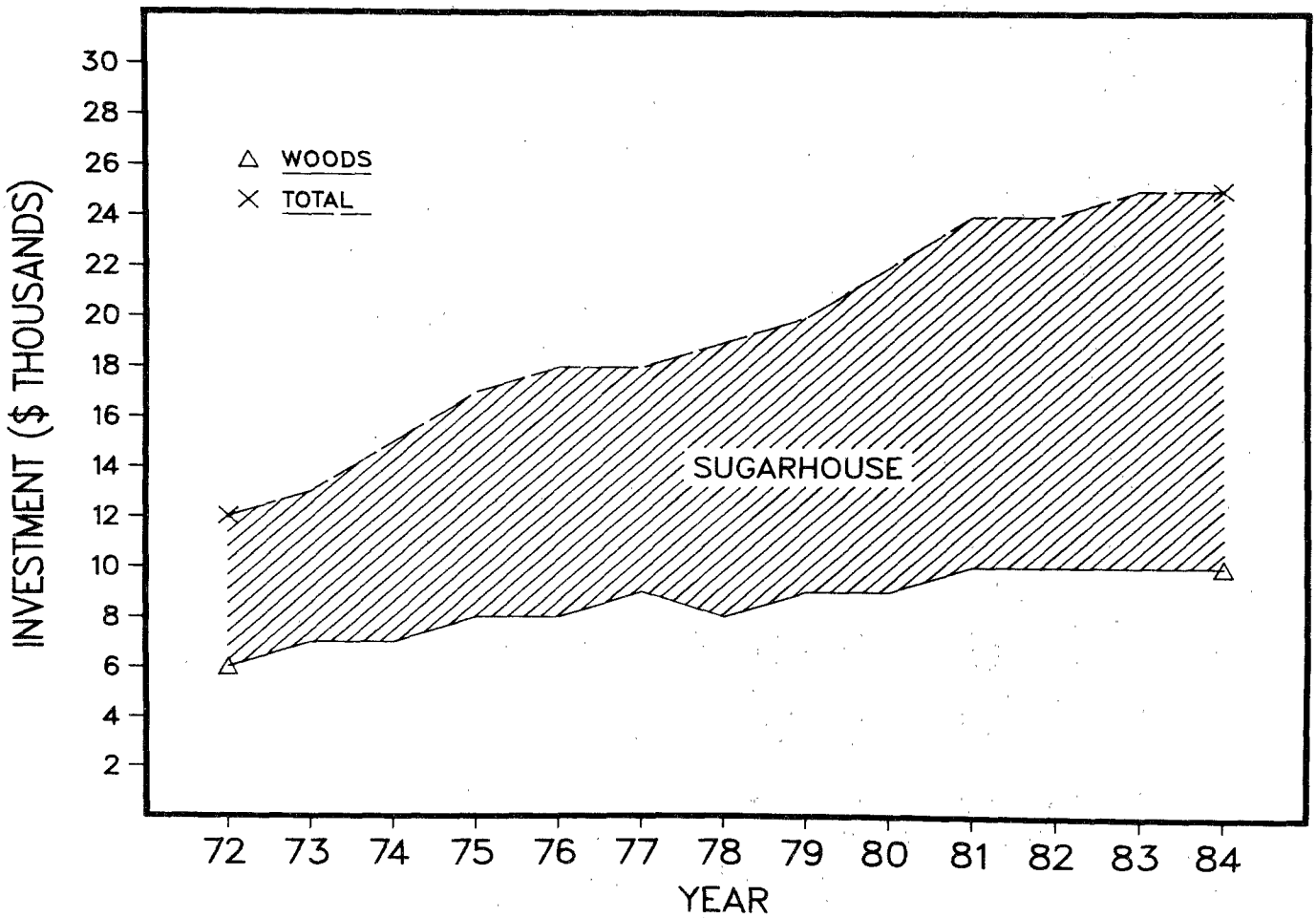


Figure 4.—Investment in sap collection equipment and syrup processing equipment and building for a 3,000-tap operation: tubing with vacuum, with an oil-fired evaporator, 1972-84.

Comparative Analyses

Investment versus annual operating cost. Investment is the money needed to purchase the equipment and building for the production of maple sap and syrup and is linked to annual operating cost through calculation of an annual equivalent of investment.[2] Annual equivalent provides for both repayment of the investment and a return on the investment for the life of the building or equipment (Smith 1968). Annual operating cost is incurred each year in the production operation and includes cash items, such as fuel and wages, and non-cash items, such as annual equivalent of investment in equipment and the opportunity cost of the operator's time. The annual operating cost is the same as production cost presented in Figure 2.

Investment can be separated into the woods or sap collection activity and the sugarhouse or syrup processing activity (Fig. 4). Investment in both woods and sugarhouse increased steadily since 1972 but leveled off in 1983 and 1984. During this period, investment doubled from $12,500 in 1972 to $25,000 in 1984 (3,000 taps, tubing with vacuum, and oil-fired). Investment increased more rapidly for syrup processing than for sap collection. In 1972, sap collection was about 50 percent of total investment and only 40 percent in 1984.

[2] $A = B\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$

where A = annual equivalent of investment,
B = investment,
i = interest rate,
and n = life of building or equipment.

Note: Salvage value is assumed to be zero.

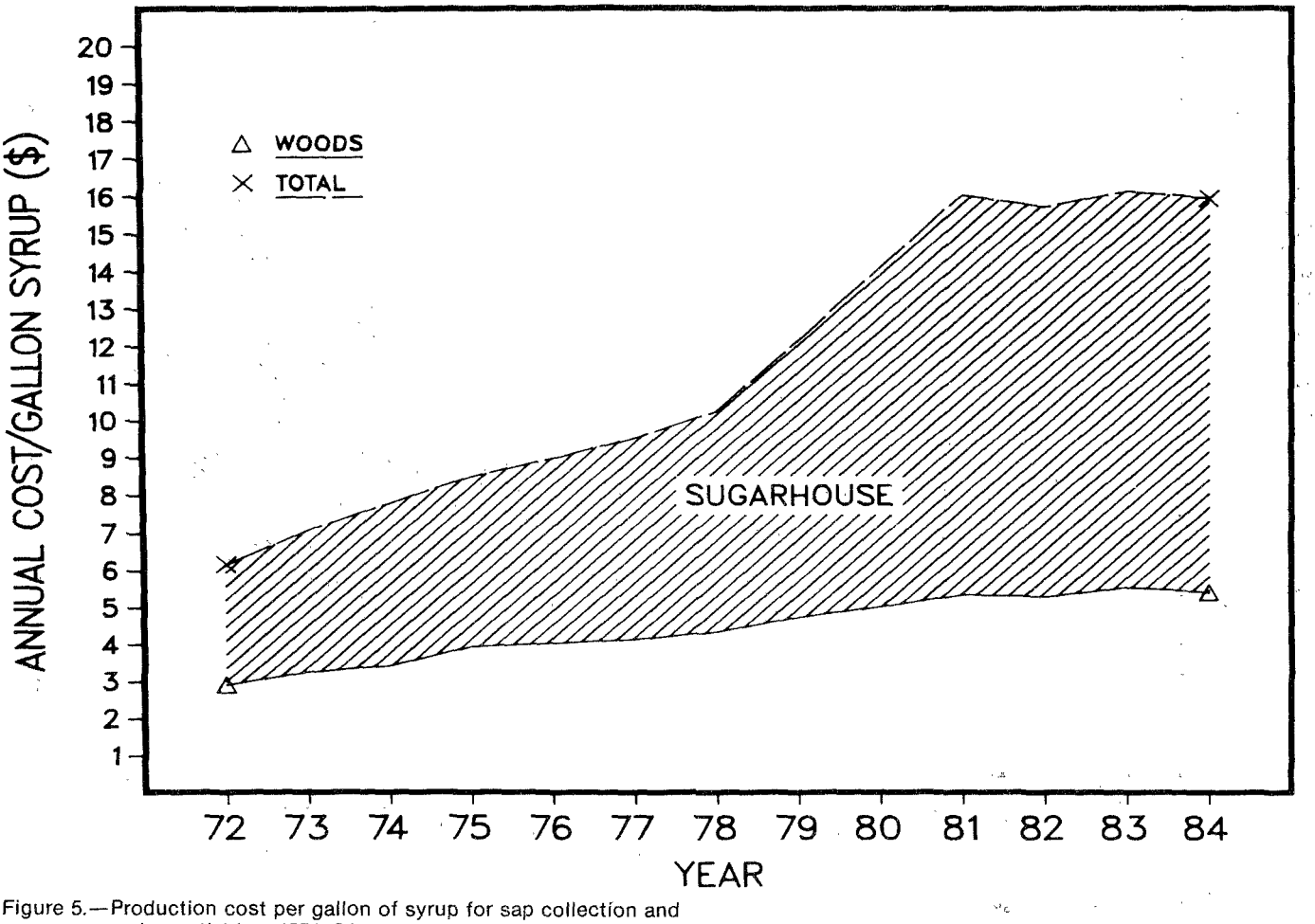


Figure 5.—Production cost per gallon of syrup for sap collection and syrup processing activities, 1972-84.

Woods versus sugarhouse: annual operating cost. The sap collection (woods) and syrup processing (sugarhouse) activities changed at different rates for annual operating cost as well as investment cost (Fig. 5). In 1972, the woods activities accounted for 47 percent of the total syrup production cost compared to 34 percent in 1984. The higher investment for syrup processing and the increase in fuel oil price account for most of the increase.

Changing technology: tubing versus buckets. Collecting sap in galvanized iron buckets was standard in the industry for many years. In the 1950's plastic tubing was introduced. After several years of trials and experimentation, a superior technique was developed—the closed dropline aerial system with vacuum pumping (Walters 1982).

Advantages of tubing over bucket systems are reflected in cost of operation. Huyler (1975) estimates that a tubing system requires 22 percent less labor time than a bucket system and yields 28 percent more sap per tap. In addition, tubing systems require a lower capital investment per tap than buckets. In 1972, the annual operating cost per gallon of syrup was $7.56 for buckets and $6.16 for tubing. In 1984, it was $21.33 for buckets and $15.93 for tubing (Fig. 6). The cost gap between the two systems has steadily widened. In 1972, tubing represented 81 percent of the annual cost per gallon for buckets; in 1984 it was 75 percent.

Fuel choice: wood versus oil. In the 1950's, fuel oil began to replace wood as an evaporator fuel because it was cheap, clean, and

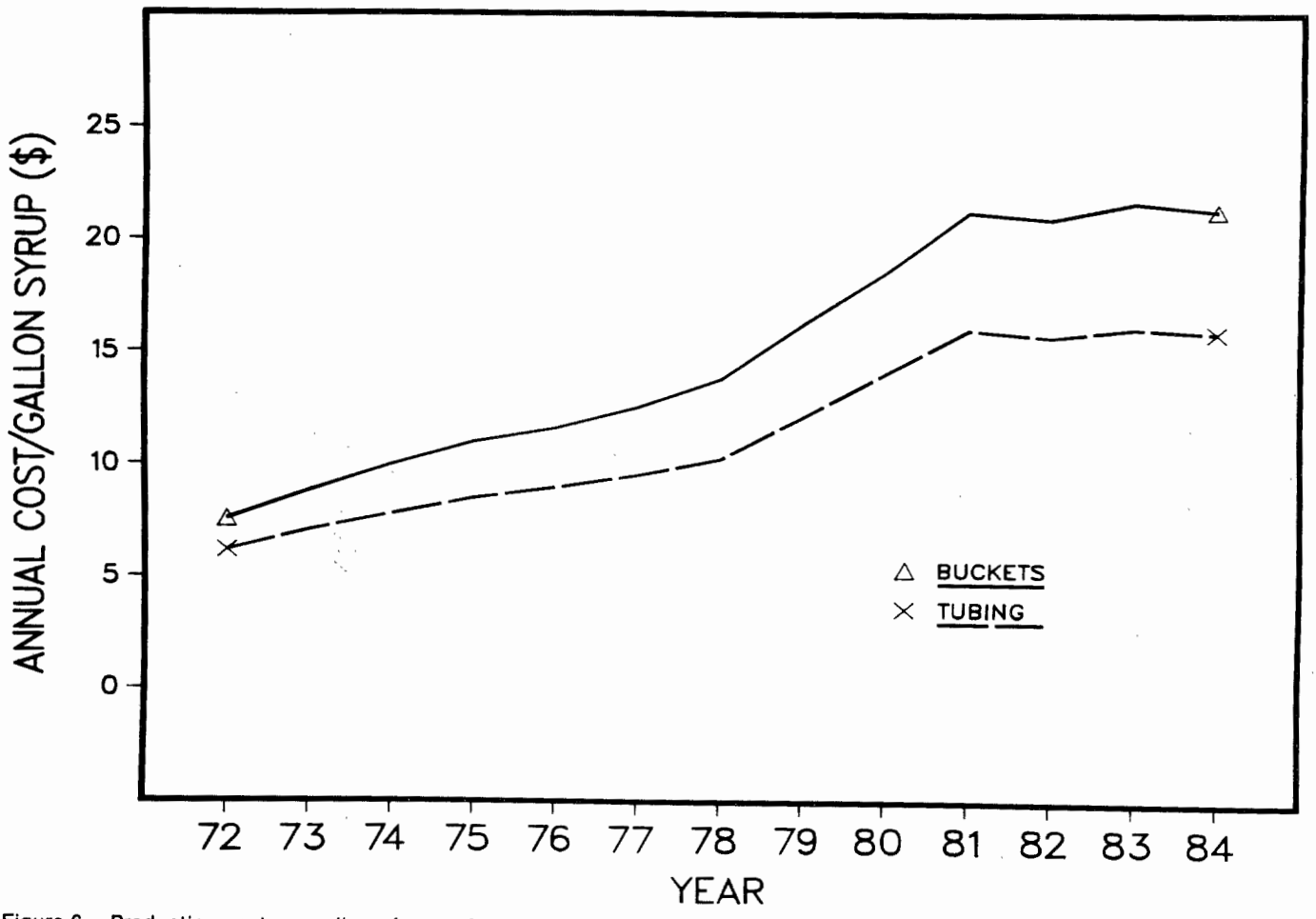


Figure 6.—Production cost per gallon of syrup for tubing with vacuum operation compared to a bucket operation, 1972-84.

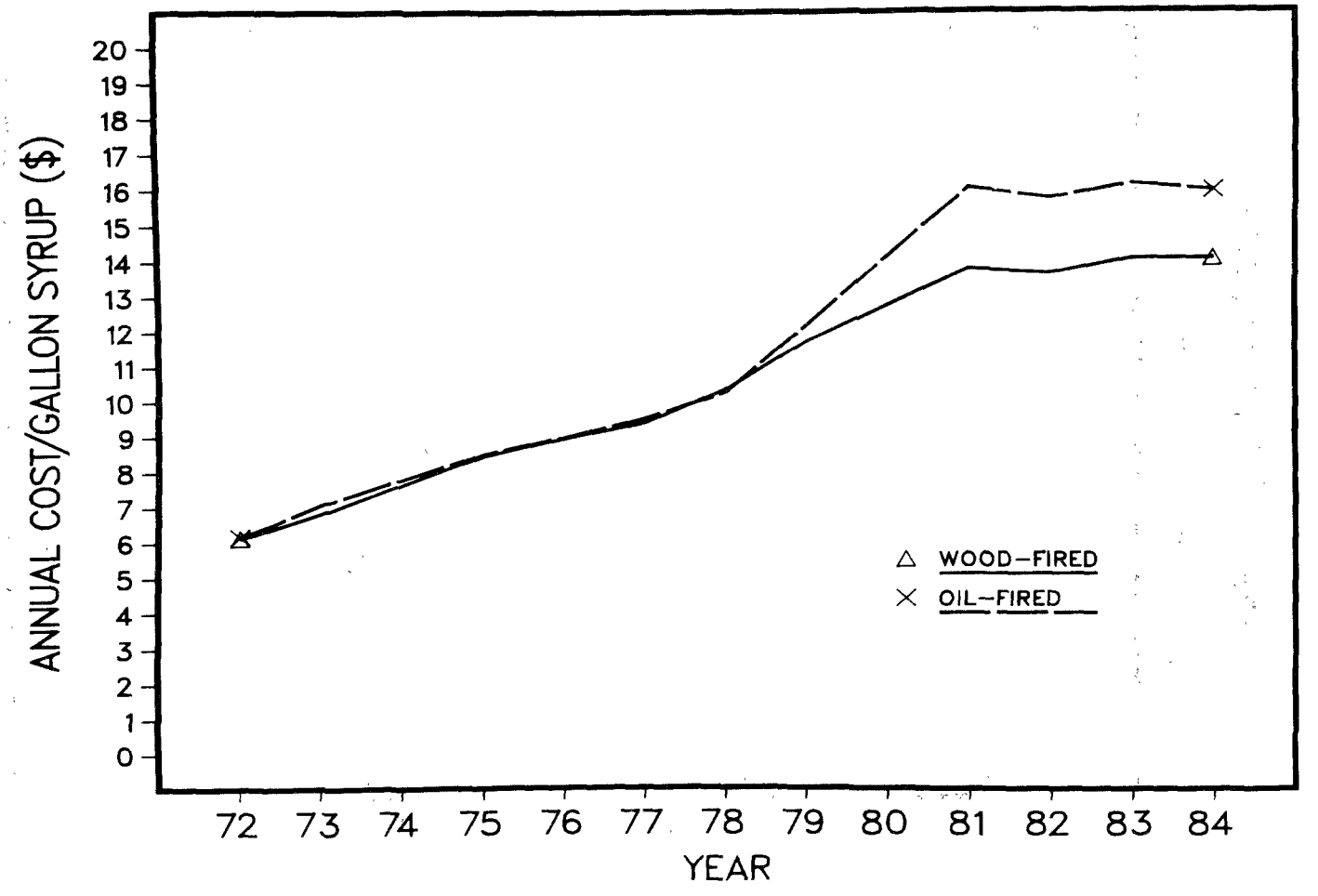


Figure 7.—Production cost per gallon of syrup for an oil-fired operation compared to a wood-fired operation, 1972-84.

more efficient. During the 1970's, oil had increased in price to such a level that its impact on syrup production cost overwhelmed its convenience value and other advantages. From 1972 to 1984, the price of No. 2 fuel oil rose from $.30 to $1.24 per gallon. Figure 7 shows how rising oil prices affected the annual cost of producing syrup. In 1972 through 1978, the two fuels yielded comparable production costs. However, in 1979 this changed and by 1984 wood-fueled production cost was 12 percent lower than oil-fueled.

Sap Sugar

Natural variability among individual trees and environmental factors influence sap-sugar content and flow (Gabriel 1982, Gregory 1982). Gabriel (1972) reported a range in sap-sugar content of from 0.7 to 10.8 percent for 21,080 trees in the Northeast. A widely accepted average for commercial sugarbushes in Vermont is 2.5 percent sugar content and a yield of 10 gallons of sap per tap. A base of 2.15 percent sugar and a yield of 10 gallons was used for calculating production costs per gallon of syrup for a bucket operation.

Production costs vary with sugar content because of changes in the amount of water removed per gallon of syrup. For example, 100 gallons of 2 percent sap will yield 2-1/3 gallons of syrup, while the same amount of 4 percent sap will yield 4-2/3 gallons of syrup, or twice the syrup for about the same total processing cost.

Figure 8 shows how production costs per gallon of syrup change with changing sugar content. A 100 percent change in sugar content from 1.5 percent to 3.0 percent resulted in a 40 percent decrease in production cost from $20.98 per gallon of syrup to $12.64.

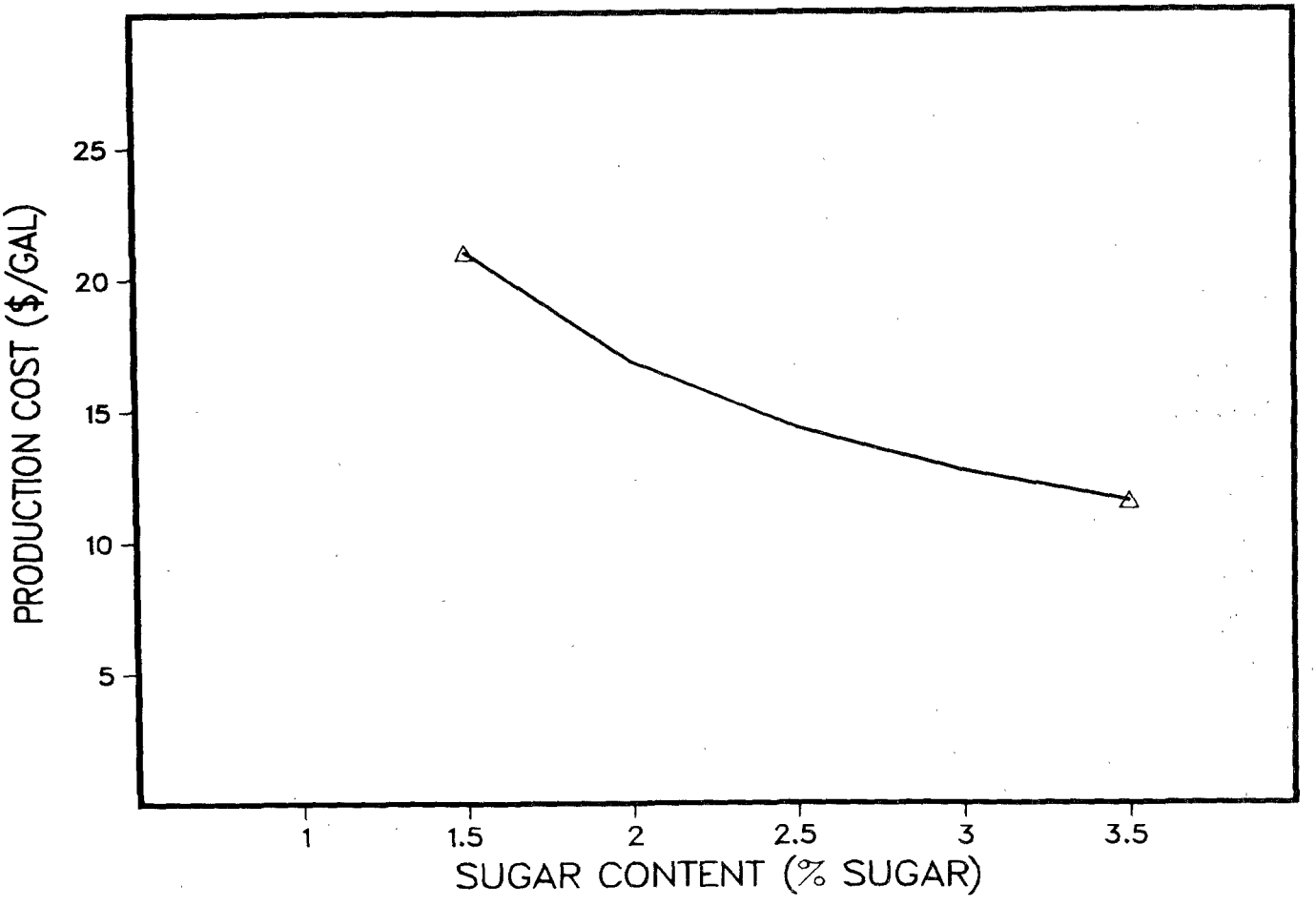


Figure 8.—Production cost per gallon of syrup related to average sugar content of sap.

Scale Effects of Economies of Size

Scale effects in maple sugaring can be attributed to more efficient use of equipment with increasing size. For example, items such as tools, tree power-tapper, vacuum pump system, and many items in the sugarhouse are needed for all operations regardless of size. They are fixed costs with respect to the operation. However, when averaged over more taps and gallons of syrup in larger operations, they decrease on a per tap or per gallon basis. In 1984, production costs per gallon were $17.64, $15.93, and $15.14 for a 2,000-, 3,000-, and 4,000-tap operation, respectively.

Sensitivity Analysis

Total production cost is a summation of the individual cost items. Over time, the items change in price or value in absolute terms and relative to each other. Small changes in major cost items can have a greater impact on the total than large changes in minor cost items. The sensitivity of total production cost in 1984 to individual changes in the major cost items was tested.

Change in fuel oil and labor costs resulted in the largest change in total production cost per gallon of syrup (Table 1). An increase of 50 percent in the cost of fuel oil resulted in an increase of 14 percent in total cost. An increase of 50 percent in the cost of labor resulted in an increase of 10 percent in total cost. An increase of 50 percent in the other major cost items resulted in increases in total production cost of from 2 to 9 percent.

Summary and Conclusions

Cost of maple syrup production increased from 1972 to 1984 reflecting the rise in the general price level as measured by the CPI. However, the difference between the maple syrup production cost index and the CPI was as great as 18 points for 1 year. Although the maple industry cost trend may follow the trend in the CPI, characteristics of the industry may cause production costs to change more or less than changes in the CPI. For example, maple production is fuel intensive so that increased fuel oil prices have a greater influence on syrup production cost than on the CPI.

Syrup price has also increased over the period studied. However, after removing the increase caused by inflation, there was no change in either production cost or price expressed in dollars of constant value.

During the study period major shifts related to cost have occurred in the industry. The sugarhouse or syrup processing center has become the major cost center in the production process. In 1972, syrup processing accounted for 53 percent of total cost, and in 1984, 66 percent. Production cost using plastic tubing has decreased relative to production cost using buckets. In 1972, syrup production cost using tubing was 81 percent of cost using buckets. In 1984, the percentage dropped to 75 percent. Additions to existing maple operations and new operations will most likely use plastic tubing.

The analysis identified changes that could lower the cost of syrup production. In 1984, wood-fueled evaporation yielded total cost 12 percent lower than oil-fueled evaporation. Processing sweeter sap, say 3 percent sap versus 1.5 percent sap, can lower cost by 40 percent. Production cost per gallon at the 3,000-tap level is lowered by 10 percent compared to production at the 2,000-tap level. These options are not always a matter of choice for the operator. But when options are available, the operator can estimate the effect on production cost.

The analysis indicates that efforts to increase fuel efficiency and labor productivity have the greatest potential to reduce total production cost. It helps explain why an innovative technology such as sap concentration using reverse osmosis is a serious alternative to oil-fired evaporation (Sendak and Morselli 1984).

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Appendix

Table 1.—Sensitivity of total maple syrup production cost[a] to change in major cost items, 1984 costs as a base

Item	Change in cost or value of item	Change in total production cost
	Percent	
Fuel oil	+50	+14
Labor	+50	+10
Sap collection equipment	+50	+ 9
Evaporator	+50	+ 7
Interest rate	+50	+ 5
Packaging	+50	+ 5
Sugarhouse	+50	+ 2

[a] Assumes a 3,000-tap operation, tubing with vacuum and an oil-fired evaporator.

Table 2.—Standard equipment list for bucket systems

Item	Quantity
15-quart sap bucket	1 per tap
Sap bucket cover	1 per tap
Metal sap spout	1 per tap
20-quart gathering pail	2 per operation
Bucket washer	1 per operation
Snowshoes (pair)	1 per operation
Power tree tapper	1 per operation
Tapping bit	1 per operation
Bit file	1 per operation
Spark plug	1 per operation
Hand tool set	1 per operation
Tractor (prorated)	1 per operation
Sap sled	1 per operation
10-barrel gathering tank	1 per operation

Source: Huyler 1975.

Table 3.—Standard equipment list for tubing-vacuum systems

Item	Quantity
Nylon sap spout	1 per tap
5/16-inch sap tubing	15 feet per tap
1/2-inch mainline tubing	2 feet per tap
3/4-inch mainline tubing	1.2 feet per tap
1-inch mainline tubing	0.7 feet per tap
5/16-inch connector	0.05 per tap
1/2-inch connector	0.02 per tap
3/4-inch connector	0.012 per tap
1-inch connector	0.007 per tap
5/16-inch end cap	0.04 per tap
5/16-inch tee	1 per tap
4-way wye	0.02 per tap
1- x 3/4-inch reducer	0.002 per tap
3/4- x 1/2-inch reducer	0.004 per tap
Quick clamp	0.082 per tap
Aluminum fence wire	0.7 foot per tap
Quick clamp pliers	1 per operation
Wire ties	1 per operation
Wire tier	1 per operation
Fence wire stretcher	1 per operation
Spout puller	1 per operation
Sap pump	1 per operation
50-gallon vacuum storage tank	1 per operation
Snowshoes (pair)	1 per operation
Power tree tapper	1 per operation
Tapping bit, bit file and spark plug	1 per operation
Hand tool set	1 per operation

Source: Huyler 1975.

Table 4.—Standard equipment list for syrup processing by fuel type and tap size[a]

Item	Wood			Oil		
	2,000 taps	3,000 taps	4,000 taps	2,000 taps	3,000 taps	4,000 taps
Evaporator[b] (feet)	5 x 12	5 x 16	6 x 16	5 x 12	5 x 16	6 x 16
Sap storage tank capacity (gallon)						
Buckets	2,500	3,750	5,000	2,500	3,750	5,000
Tubing	3,160	4,740	6,320	3,160	4,740	6,320

[a] Additional equipment that does not vary with size of operation or fuel type includes: 30-gallon filter tank, 3- x 3-foot flat rayon filters, syrup hydrometer and cup, syrup skimmer, syrup grading set, automatic draw-off.
[b] Evaporators are fully equipped as recommended by the manufacturer including grate for wood-fired evaporators, oil burners and a 1,000-gallon fuel tank with oil-fired evaporators, arch insulation, fire brick, and retort cement as required.
Source: Huyler and Garrett 1979.

Table 5.—Variables and value used in production cost computer program, 1972 to 1984

Variable	Value	Source
Sugarhouse size (square feet)		Wells 1977
Wood-fired 2,000-tap	710	
3,000-tap	880	
4,000-tap	1,000	
Oil-fired 2,000-tap	560	
3,000-tap	650	
4,000-tap	680	
Labor		
Sap collection (hour/tap)		Huyler 1975
Buckets	0.205	
Tubing	0.160	
Syrup processing (hour/season)		Huyler and Garrett 1979
Wood-fired	140	
Oil-fired	130	
Packing (hour/gallon)		Report of the Governor's Maple Industry Task Force 1975[a]
Bulk	0.0080	
Wholesale	0.0110	
Retail (gal)	0.0167	
(qt)	0.0278	
Energy consumption		Huyler and Garrett 1979
Wood (cord/gal syrup)	0.04	
No. 2 oil (gal/gal syrup)	3.50	
Electricity (kWh/tap)	0.033	
Economic life (years)		
Buckets	30	Huyler 1975
Tubing	10	
Sugarhouse	25	Huyler and Garrett 1979
Evaporator	20	
Percentage of maple syrup sales		United States Department of Agriculture, Statistical Reporting Service 1972–1984
Retail	51.6	
Bulk	32.3	
Wholesale	16.1	

[a] Report of the Governor's Maple Industry Task Force. 1975. Unpublished, on file at USDA Forest Service, Northeastern Forest Experiment Station, Burlington, VT.

Table 6.—Source of price information for maple syrup production cost and revenue, 1972 to 1984

Item	Source
Standard equipment	
Maple equipment	G. H. Grimm Co., Rutland, VT (Annual Catalog) Leader Evaporator Co., St. Albans, VT (Annual Catalog) Reynolds' Sugarbush Co., Aniwa, WI (Annual Catalog)
Hand tool set	Sears Roebuck and Co., Chicago, IL (Annual Catalog)
Snowshoes	L. L. Bean Co., Freeport, ME (Winter Catalog)
Fuel storage tank	Webb Fuel Co., Williston, VT (personal communication)
Tractor (60-horsepower, Ford F-4000)	Yandow Sales and Service, North Ferrisburg, VT (personal communication)
Operation expenses	
Property tax rate	Real Estate Guide, Andover, MA
Wages	Vermont Department of Employment and Training, Research and Statistics Section, 1972-1982, Montpelier
Interest rate (3-month U.S. Treasury Bills)	Council of Economic Advisers
Insurance Rate	Hickok and Boardman Inc., Burlington, VT
Energy	
No. 2 fuel oil	Energy news. VT Department of Energy, Montpelier
Fuelwood	New Hampshire Department of Resources and Economic Development
Electricity	Green Mountain Power Corp., Burlington, VT (Annual Report) Central Vermont Public Service Co., Middlebury/St. Albans, VT (Annual Report)
Revenue	
Average syrup price (all sales)	United States Department of Agriculture, Statistical Reporting Service
Syrup sales proportion	United States Department of Agriculture, Statistical Reporting Service

Sendak, Paul E.; Bennink, John P. **The cost of maple sugaring in Vermont.** Res. Pap. NE-565. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 14 p.

An annual maple syrup production cost series was developed for the period 1972 to 1984. Comparisons were made between plastic tubing and metal bucket technology and wood- and oil-fired evaporation. The effects of sap-sugar content and size of operation were examined together with the relationships among major cost items. The information will be useful to maple syrup producers and lenders needing financial analyses, equipment developers and manufacturers, and public policy analysts and planners.

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Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

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