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A COST ANALYSIS: PROCESSING MAPLE SYRUP PRODUCTS

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Abstract

A cost analysis of processing maple sap to syrup for three fuel types, oil-, wood-, and LP gas-fired evaporators, indicates that: (1) fuel, capital, and labor are the major cost components of processing sap to syrup; (2) wood-fired evaporators show a slight cost advantage over oil- and LP gas-fired evaporators; however, as the cost of wood approaches $50 per cord, wood as a fuel would no longer have this cost advantage; (3) economies of scale exist in processing maple sap to syrup; (4) in 1977 the total cost of production, including both sap production costs and processing costs, for a medium-size (750) gallons of syrup) operation was $8.36 per gallon of syrup for oil-fired evaporators, $7.97 per gallon of syrup for wood-fired evaporators, and $8.37 per gallon for LP gas-fired evaporators.

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INTRODUCTION

THE ECONOMICS of processing maple sap to syrup is important to the producer of maple syrup products. Equipment, labor, and energy costs are rising sharply, reducing profits with every incremental increase, and placing many producers in a cost-price squeeze.

Early settlers produced maple syrup primarily as a sweetner for household use rather than as a product for trade, so production costs were not a major consideration. Today, however, maple syrup products are produced as a cash crop to provide supplemental income to the farm. There also is a trend toward large-scale operations that are the sole or primary source of income.

Today's commercial maple processing plants require a substantial investment, and rising costs make it necessary for the industry to fully understand production costs and their efffect on the future supply of maple syrup products. Costs of syrup production can be divided into two components, the extraction and collection of maple sap and the processing of sap to syrup. Although the processing component is evaluated in this paper, a brief summary of sap collection costs is appropriate.

In evaluating costs associated with the production of maple sap, Huyler (1975) and Gunter and Koelling (1975) concluded that the initial investment cost per tap is lower when plastic tubing rather than the traditional metal bucket is used to collect sap. Although the cost varied with the size of an operation (usually lower for larger operations), the average investment cost per tap was $1.74 for the tubing system compared to $2.07 per tap for the bucket system.

The results also showed that the tubing system required less labor time than the bucket system—9.6 minutes per tap for tubing versus 12.3 minutes per tap for buckets. In addition, the preparation and installation of a tubing system requires the greatest concentration of labor before the sap-flow period. The labor is therefore, available for sugarhouse activities as soon as the sap begins to flow. Conversely, a bucket system requires the greatest concentration of labor during sap flow.

A critical finding of the sap production studies was that total annual costs were an average of 8 percent less for a tubing system than for the bucket system. In 1974, an operator using plastic tubing incurred a total annual cost of approximately $0.86 per tap compared to about $0.93 per tap for a similar operation in which buckets were used. Because of lower annual costs, the tubing operator could break even at approximately 900 taps compared to 2,200 taps for a bucket operator. If one assumes an average of four taps to produce a gallon of syrup, the total annual cost of sufficient sap to produce a gallon of syrup in 1974 was $3.44 (4 x $0.86) for tubing systems and $3.72 (4 x $0.93) for bucket systems.

The cost of tubing systems has not increase significantly since 1974. An analysis of these operations in 1977 revealed that the total annual cost of sufficient sap to produce a gallon of syrup was $3.65, an average increase of only $0.21 per gallon syrup equivalent since 1974.

Costs associated with producing sap are nearly one-half of those requried to produce a gallon of syrup. The remaining total costs in producing a gallon of syrup are incurred in the processing plant or the sugarhouse.

It should be understood that the cost of processing sap to syrup is not and should not necessarily be separated from the cost of sap porduction as was done in this study. We took this approach so that producers who are presently producing only sap or who are purchasing sap and processing it to final syrup products can estimate the cost of sap or syrup production or both. this method also is appropriate for potential entrepreneurs who plan to enter either production phase, but not both.

METHODS

Time and motion studies were conducted at nine maple syrup processing plant during the 1974 and 1975 maple seasons. All costs associated with syrup production for each operation were tabulated, including those for land, building, plant equipment, labor, fuel, electricity, and miscellaneous cost items.

Nine "conventional" or stadard sample evaporators as designed by commercial manufacturers were evaluated. These evaporators were separated into three groups by fuel type. Group 1 was No. 2 oil fired, Group 2 was wood fired, and Group 3 was LP gas fired. Within each group were three levels of syrup production, approximately 500, 750, and 1,000 gallons.

Capital, labor, fuels costs, taxes

Capital costs, which include land, building, and plant equipment, were amortized over a 20-year useful life for plant equipment and a 25-year useful life for building and land at 10 percent interest on investment. The cost associated with building construction was based on farm-type structures at a cost of $3.50 per square foot. All equipment costs are based on 1977 prices.

Labor for the production process was charged at a rate of $4.00 per hour. This figure includes the owner-operator and any hired or family labor used in the operation.

Fuel costs were based on average current market prices. The average cost of No. 2 fuel oil was $0.495 per gallon, the average cost of wood was $40.00 per cord, and the average cost of LP gas was $0.505 per gallon. The cost of electricity used was $0.045/kwh. All other miscellaneous costs represent an average of existing market prices for products or services used by the processing plant.

Taxes were estimated at $8.00 per $100.00 and based on 50 percent of the fair market value of land and building. Insurance was estimated at $0.75 per $100.00 of original investment.

Real costs

Since maple syrup production is primarily a farm-oriented business, no two operations have identical production costs. Many have older plants and equipment which are fully depreciated and, therefore, do not carry equipment costs. Further, many operations do not charge the labor rates which we have charged to our labor, and some do not attach a charge for family labor.

To fully evaluate the total annual cost of production, both noncash items, such as interest or borrowed capital, depreciation expense on building and equipment, and cash items, such as labor, fuel, electricity, taxes, insurance, and any miscellaneous expense, should be combined to determine the total annul cost of production.

RESULTS AND DISCUSSION

Essential to any new business are two forms of capital, investment capital which makes it possible to assemble the physical resource required for production, and operating capital, which is used after the physical resource has been assembled. When the production process begins, other costs—such as labor, energy, and a multitude of miscellaneous costs—are incurred.

Capital investment

An operating maple producer or an entrepreneur planning to invest in maple syrup processing plant must allocate monies for items such as land, processing equipment, building, and storage facilities. For the operators studied we found that total capital investment increases as plant size increases; however, land and building costs do not increase in direct proportion to the volume of syrup produced because 1 acre of land is sufficent for both small and large operations, and building size does not double as volume doubles.

A breakdown of total capital investment for small, medium, and large maple syrup operations by fuel type is shown in Table 1. Small, medium, and large maple operations using oil, wood-, or gas-fired evaporators differed little in total capital requirements. Small plants required an outlay of approximately $8,500, whereas medium- and large-size plants required approximately $9,500 and $11,500, respectively.

Processing equipment represents the largest single component of the total investment cost for processing maple sap to syrup—aproximately 70 percent. Larger operations may also require specialized equipment for syrup draw-off, syrup finishing, and standardizing packaging. However, mechanical filtering, standardizing, and packaging equipment is excluded from the capital investment.

Table 1.—Investment cost for small, medium, and large maple syrup operations

Item	5' x 12' Small 1500-2000 taps 375-500 gal syrup	Investment Cost 5' x 16' Medium 2100-3000 taps 525-750 gal syrup	6' x 16' Large 3100-4000 taps 775-1000 gal syrup
		Dollars	
Land (1 acre)	1,000	1,000	1,000
Building @ $3.50 ft.^{2}	2,058	2,279	2,387
Wood shed @ $2.00 ft.^{2}	480	672	912
Processing Equipment[a]			
Oil rig	5,481	6,577	8,278
Wood rig	4,591	5,665	6,882
Gas rig	5,501	6,660	7,885
Total oil	8,539	9,856	11,665
Total wood	8,129	9,616	11,181
Total gas	8,559	9,939	11,272

[a]Does not include filter and packaging equipment.

Processing equipment for oil-fired systems require the highest investment and wood-fired systems the least. However, there is an additional cost of a storage shed for the wood-fired system, so the total investment for each system in nearly equal.

Annual production cost

Depreciation and interest. Of the several "non-cash" elements in any business, depreciation is usually the least understood and the one that many maple producers disregard in their cost analysis. The primary importance of depreciation is its effect on income taxes; therefore, it will be reflected in the business cash flow and/or net profit.

Although depreciation has many meanings and can be computed in several ways, its use in the context of this analysis is usually termed amortization. The objective is to recover completely the original investment cost by charging an annual amount over the useful life of the the investment. In this case, syrup processing equipment has an estimated useful life of 20 years and the building a useful life of 25 years with no salvage value.

Interest on borrowed capital is also an important cost item in estimating the annual production cost. Interest is simply the rental price of money that has been borrowed to be placed into operation. For this analysis an annual interest rate of 10 percent was charged to the capital investment.

One method of relating both depreciation and interest cost in determining the annual cost of capital is to use a capital recovery factor.[1] This is simply multiplying the original investment by a factor to determine the annual payment needed to recover the original investment plus interest over a specified period. This method was used to estimate the annual equipment cost (interest and depreciation) for each size and type of operation (Table 2).

Capital cost accounts for approximately one-third of the total annual cost for processing sap to syrup (Fig. 1). The annual cost of capital decreases as size increases for each fuel type, indicating that economics of scale exist for larger plants (Table 2). Wood-fired evaporators had a slight cost of capital advantage over the No. 2 oil-fired and gas-fired evaporators, but the difference was marginal.

Labor costs. Labor accounted for 15 to 17.5 percent of the total annual cost of processing sap to syrup. All fuel types and size classes studied required approximately 130 to 140 hours per season for processing. The wood-fired evaporators re-

[1]Capital recovery factor $a = Vo \dfrac{i(1+i)^n}{(1+i)^n - 1}$

where a = the annual payment; Vo = original investment;
i = the rate of interest; n = number of years depreciated.

Table 2.—Annual production costs for small, medium, and large maple processing plants, by fuel type

Item	No. 2 fuel oil			Wood			LP gas		
	Small	Medium	Large[a]	Small	Medium	Large	Small	Medium	Large
	Dollars per gallon of syrup								
Depreciation & Interest									
Land & Building	0.67	0.48	0.37	0.78	0.58	0.47	0.67	0.48	0.37
Processing equipment	1.28	1.03	.97	1.08	.89	.80	1.29	1.04	.93
Taxes & Insurance[b]	.36	.26	.22	.39	.30	.25	.36	.26	.22
Labor[c]	1.04	.69	.52	1.12	.75	.56	1.04	.69	.52
Fuel[d]	1.98	1.98	1.98	1.60	1.60	1.60	2.03	2.03	2.03
Electricity & Miscellaneous	.24	.27	.28	.20	.20	.20	.21	.22	.22
Total	5.57	4.71	4.34	5.17	4.32	3.88	5.60	4.72	4.29

[a] Small, medium, large represent production rate of 500, 750, 1000 gallons of syrup, respectively.
[b] Estimated @ $8/$100 for land and building, Insurance was estimated @ $.75/$100 of original investment.
[c] Charged @ $4/hr for both family and hired labor.
[d] Charged @ $.495/gal. for No. 2 fuel oil, wood @ $40/cord, and LP gas @ $.505/gal.

quired slightly more labor than the oil- and gas-fired evaporators. Labor costs for oil- and gas-fired evaporators ranged from $0.52 to $1.04 per gallon of syrup. The labor cost required for wood-fired evaporators ranged from $0.56 to $1.12 per gallon of syrup, an increase of about 8 percent.

Owner-operator labor was the primary input in the maple processing plant. In general, hired labor is used more for the woods part of the operation than in the actual processing of sap to syrup. Labor other than that of the owner-operator was used least in the filtering and packaging of syrup products; however, these labor inputs are part of marketing costs and were not included in the analysis.

Energy costs. Cost comparisons on the basis of Btu yield showed that LP gas and oil were the most expensive fuels used by producers, accounting for 43.0 and 42.0 percent of the total annual cost, respectively (Fig. 1 and Table 2). Wood was the least expensive fuel, accounting for 37.1 percent of the total annual cost.

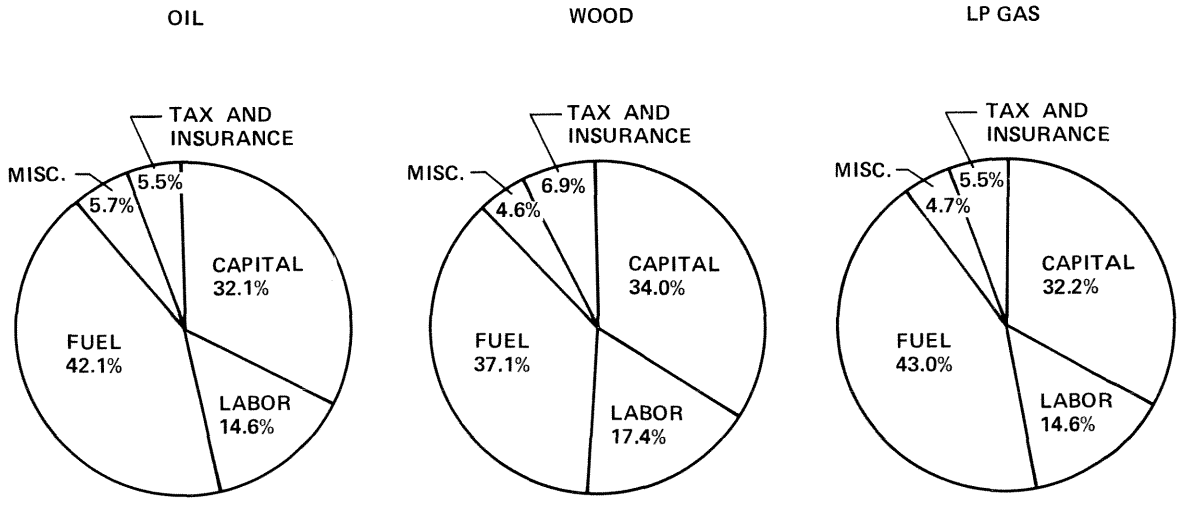

Figure 1.—Percentage breakdown of total costs for three types of fuel used in processing maple sap to syrup in a medium-size (750 gallons of syrup) operation.

The cost of energy in processing maple syrup products relates directly to the efficiency of the evaporation system used. Of the systems studied the wood-fired evaporators operated at between 40 and 50 percent efficiency; efficiency was between 60 and 65 percent for oil-fired evaporators, and between 65 and 70 percent for the gas-fired evaporators.

Energy requirements for processing pure maple syrup are best expressed in a fuel to syrup ratio. In the operations studied, between 3.5 and 4 gallons of No. 2 fuel oil were used to process 1 gallon of syrup. In general, oil used had a higher heat value (HHV)—19,500 Btu per pound. However, this total heat yield was not realized because the oil-fired evaporators operated at only 60 to 65 percent efficiency.

Wood-fired evaporators consumed approximately 1 cord of wood for every 25 to 30 gallons of syrup produced. The wood used had a HHV between 23 and 26 million Btu per cord. These Btu were reduced by moisture content and evaporator design so that only 40 to 50 percent of the total heat input was transferred to evaporated steam.

Gas-fired evaporators consumed approximately 5 gallons of LP gas to produce 1 gallon of syrup. The gas used had a HHV of 91,000 Btu per gallon; of this total, approximately 65 to 70 percent was transferred to evaporated steam.

We calculated the energy cost per gallon of syrup for the three fuel types. The average cost for No. 2 fuel oil at the rate of $0.495 per gallon of oil was $1.98 per gallon of syrup. The average cost for wood at the rate of $40.00 per cord was $1.60 per gallon of syrup; at the rate of $0.505 per gallon, the average cost for LP gas was $2.03 per gallon of syrup (Table 2). If the cost of wood were more than $40.00 per cord, the cost per gallon of syrup for this fuel type would approximate that for oil and gas.

Taxes, insurance, miscellaneous costs

Other costs incurred in maple syrup processing include those for taxes, insurance, electricity, and miscellaneous items. These costs are generally minor in relation to the total cost of operating the plant; that is, together they account for only slightly more than 10 percent of the total annual cost of producing a gallon of syrup. However, they should not be overlooked in the cost of production (Table 2).

Total annual cost

We have seen that the major cost components for the three fuel types in processing sap to syrup are fuel, capital (interest and depreciation), and labor. These components account for approximately 90 percent of the total annual cost. In costs per gallon of syrup, the total annual cost for oil-fired evaporators ranges from a high of $5.57 per gallon of syrup to a low of $4.34 per gallon (decreases as size or production level increases (Table 2). The total annual cost of operating wood-fired evaporators ranges from $5.17 per gallon of syrup to $3.88 per gallon (decreases as production level increases). Costs for gas-fired systems range from $5.60 per gallon of syrup to $4.29 per gallon (Table 2).

Of the evaporators studied, wood-fired evaporator incurred the lowest total annual cost. This is directly attributable to the lower cost of wood used for fuel. But other factors must be considered when using wood—amount of wood required, availability, convenience, etc.

It should be noted that the costs shown in Table 2 are those associated only with processing sap to syrup. To determine the total cost of producing a gallon of syrup, the cost of sap production should be included. As noted earlier, the average annual cost of sap production for tubing systems in 1977 was $3.65 per gallon of syrup equivalent. This includes the cost of capital (interest and depreciation), labor, and costs of fuel, taxes, insurance, and miscellaneous items.

Table 3 shows the sap production cost for a 3,000 tap or 750 gallons of syrup production level

Table 3.—Total costs of manufacturing pure maple syrup for three fuel types (includes both sap production costs and processing costs)[a]

Activity	No. 2 fuel oil	Wood	LP gas
	- - Dollars per gallon of syrup - -		
Sap production	$3.65	$3.65	$3.65
Processing[b]	4.71	4.32	4.72
Total cost	$8.36	$7.97	$8.37

[a] Cost figures are for a medium or 750-gallon level of syrup production. Smaller production levels would have a slightly higher total cost and the large—1000 gallon or above—syrup production level would have a slightly lower total cost.

[b] Does not include packaging or marketing costs.

added to the processing cost per gallon of syrup for three fuel types. The No. 2 fuel oil-fired evaporators had a total production cost of $8.36 per gallon of syrup; wood-fired systems had a total production cost of $7.97 per gallon of syrup, and the cost for LP gas-fired evaporators was $8.37 per gallon of syrup. Again, the lower total cost for wood-fired evaporators is directly associated with the lower cost of wood as a fuel.

CONCLUSIONS

The cost analysis of processing maple sap to syrup revealed that:

- The major cost components for three production levels and three fuel types in order of importance were fuel, capital, and labor.
- In 1977, the total annual cost of processing maple sap to syrup for oil-fired evaporators ranged from $4.14 per gallon for larger operations to $5.57 per gallon of small ones; the cost ranged from $3.88 to $5.17 for wood-fired evaporators, and from $4.29 to $5.60 for LP gas-fired evaporators.
- At $40.00 a cord, wood-fired evaporators had the lowest total annual cost; however, at the cost of $50.00 a cord, wood used as fuel would no longer have a cost advantage over oil- or gas-fired evaporators at 1977 prices.
- As the production level increased (larger plant size), the total annual cost of processing decreased, indicating that economies of scale exist in processing sap to syrup. The economic gain was generally related to the cost of capital.
- In 1977, the total cost of production, including sap production and processing costs, for oil-, wood-, and gas-fired evaporators was $8.36, $7.97, and $8.37 per gallon of syrup, respectively.

Since 1974, processing costs have been affected most significantly by the increasing cost of energy. The average price of No. 2 fuel oil rose from $0.18 per gallon in 1971 and $0.24 per gallon in 1974 to $0.495 per gallon in 1977. A conventional oil-fired evaporator requires about 3 1/2 to 4 gallons of fuel oil for each gallon of syrup produced, so the incremental increase in total processing costs since 1973-74 from fuel oil alone is approximately $1.25 per gallon of syrup. This increase is especially significant because energy costs alone accounted for approximately 41 percent of the total cost of processing sap to syrup. From 1974 to 1977, the average farm price for all grades of maple syrup increased by only $1.76, indicating that the price of energy alone is erasing any gain due to the rise in the average market price of syrup.

Capital costs, especially those for plant equipment and building, have increased by an average of 8 percent per year since 1974. This increase also has caused a significant increase in total processing costs, since capital costs account for about 33 percent of the total processing cost.

Farm labor costs have also risen since 1974, but they have not had the same impact on total processing cost as fuel and capital costs. Labor makes up only about 15 percent of the total annual processing cost and, in certain cases, the owner-operator does not charge for his or her labor in the sugarhouse; if there is a charge, it is usually at a lower rate than that for outside labor.

Total annual processing costs have risen by about 9 percent per year since 1974, whereas the average farm price has increased by only about 7 percent per year. This economic fact points to the need for the industry to use all available cost-efficiency improvements that will effectively stabilize or reduce costs. Also, the operator should keep accurate records so that areas of high cost can be pinpointed and effective measures taken to keep those costs in line.

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