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ESTIMATION OF COSTS TO MANUFACTURE APPLEJUICE CONCENTRATE AND ESSENCE

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CONTENTS

ABSTRACT

Cost estimates and a financial analysis are presented for an all-new plant making high-density (71° Brix) applejuice concentrate and 150-fold apple essence, starting from raw apples. Hourly plant capacity is 1,000 gallons of single-strength juice, or 136 gallons of concentrate and 6 2/3 gallons of essence. Estimated fixed capital cost of the plant is $750,000, and estimated working capital $200,000. The financial analysis indicates that the plant should be profitable. All cost and price data are as of January 1973.

ESTIMATED COSTS FOR MANUFACTURING APPLEJUICE CONCENTRATE AND ESSENCE

By Victor A. Turkot, Ronald L. Stabile, and Nicholas C. Aceto[1/]

INTRODUCTION

Apple concentrate has a fairly stable market in the United States. Its uses include reconstitution to a beverage and as an ingredient in blended fruit juice drinks or ades, in jelly, and in other food products. Imports of apple concentrate, however, are competing for the domestic product. Beginning about 1963, imported apple concentrate began to be a significant factor in the U.S. market, and by early 1971 imports had increased to such an extent that the price of domestic concentrate dropped to a low of $1.80 per gallon. At this price, U.S. production would only be marginally profitable at best, supporting a price to the grower of only $10 to $15 a ton. This price does not begin to return to the grower his costs of production.

However, a new factor in the U.S. demand for apple concentrate emerged at about the time concentrate prices hit their lows. This was the use of concentrate by wineries for making apple wine and apple-based wine blends. These products are a tremendous market success. As a result of the heavy demand from wineries for apple concentrate, together with normal usage in established outlets, the price of concentrate rose to record levels, namely $4.25 to $4.50 a gallon in early 1973. Another factor responsible for this rapid increase in price was the shortages in apple crops for several years in a number of foreign countries that were large exporters of the concentrate to the United States.

At prices for concentrate prevailing in early 1973, U.S. processors should be able to make an attractive profit while also paying a price for juice apples that represents a good return to growers. As a result, a number of apple growers, processors, and packers are considering entering the field of concentrate manufacture.

The Agricultural Research Service's Eastern Regional Research Center (ERRC) has received inquiries from several U.S. apple growers for technical information on the production of apple concentrate and essence. In 1951, the Engineering and Development Laboratory of ERRC at Wyndmoor, Pa., published a report titled, "High-Density, Full-Flavor Apple Juice Concentrate, AIC-315."[2/]

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2/ Eskew, R. K., Redfield, C. S., and Phillips, G. W. M. High-density, full-flavor apple juice concentrate, U.S. Agr. Res. Serv. AIC-315, 17 pp. 1951. (Reprinted 1963.)

This report describes the processing and equipment requirements and gives estimated costs for manufacturing high-density (71 percent solids) concentrated applejuice and 150-fold apple essence, or concentrated liquid apple aroma.

In addition to information on processing technology as presented in AIC-315, figures on current costs are of vital interest. This publication, therefore, presents an updated estimate and investigation of the cost factors involved in concentrate manufacture. Included here are the capital investment required to build a plant, the costs of operating the plant, and the profits that can be expected at various selling prices for the concentrate with various prices paid for raw apples. All prices and costs in this publication are as of January 1973.

BASIC ASSUMPTIONS FOR THE MANUFACTURING PLANT

The plant envisioned here starts with raw apples, converts them to single-strength juice, and then to applejuice concentrate and essence. In the 1951 publication (AIC-315), the plant included only the facilities and equipment necessary to make concentrate and essence from applejuice.

Facilities and equipment.--In any specific situation, particularly where an established apple packer or processor decides to manufacture concentrate, some of the needed facilities, such as land, building space, and boiler capacity, could well be available. However, since we do not know the extent that such facilities are already available to the prospective manufacturers, we assumed in the cost estimates in this publication that no production facilities were available and that a complete plant would be built from the ground up. If a prospective manufacturer has some of the facilities already on hand, he can make the necessary reductions from the estimated costs given in this publication for building the plant.

Plant location.--Obviously, a plant is best located in a sizable apple-growing area where large quantities of apples are normally available for processing. The proposed size of the plant would require an input of about 14,000 tons (620,000 bushels) of apples a year at the annual production rate assumed.

Since the inquiries received have been from Michigan apple growers, the Michigan State corporate income tax rate of 7.8 percent has been used in computing the tax liability and the net profit of the proposed plant.

Process technology to be employed.--The technology will be essentially the same as in AIC-315, with a few modifications.

In AIC-315, depectinization is recommended at a temperature of 70°F or less. Current commercial practice, however, appears to favor the use of somewhat higher temperatures; at least one plant is now operating at 140°F. There are advantages and disadvantages of both high and low temperature. At low temperature, the risk of developing any "cooked" flavor in the juice, which can occur at high temperature, is eliminated. Low-temperature

depectinization, however, does require a longer time and more tank volume to permit this longer holding time, more cooling water and cooling equipment to chill the stripped juice to the lower temperature, a larger heater and more steam to reheat the juice for the subsequent vacuum evaporation step and, often, more depectinizing enzyme. For these reasons, depectinizing at low, rather than at higher, temperatures is more costly. With today's enzymes, depectinizing can be done in 3 to 5 hours at a temperature of about 115°F, with an enzyme cost of about $1.35 per 1,000 gallons of juice. Under these conditions, there is relatively little risk of a cooked flavor appearing in the concentrate, and there is also a reasonable compromise in cost.

It is also recommended that some gelatin be added to the stripped juice along with the depectinizing enzyme. The gelatin aids in clarifying the applejuice.

Another change is that a pressure-leaf filter is proposed in place of the plate-and-frame press.

In AIC-315, since packaging and sales were aimed at the household market, the essence was combined with the concentrate to give a "full-flavored concentrate" and packed in 6-ounce cans. In the present case, however, sales will be to the remanufacturing market. For this market, essence and concentrate are normally packaged and sold separately. In some end uses, such as winemaking, the essence is not needed. In jelly making it is desirable to complete the cooking of the jelly before adding the essence. Thus, packaging of the concentrate will be chiefly in 55-gallon drums, with plastic-bag inner liners and clamp-ring lids. Essence will be packed and sold in plastic jugs. A 1-gallon size has been assumed for this estimate, but other sizes could be used.

The processing steps envisioned and the equipment required are depicted in figure 1. A list of the processing equipment is given in the next section.

Scale of operations.--The capacity of the plant, in terms of single-strength applejuice produced and processed, is 1,000 gallons per hour. A yield of 160 gallons of juice per ton of apples was assumed. This corresponds to a yield, by weight, of 70 percent of apple weight. Thus, the apple-feed rate is 6.25 tons or 278 bushels per hour.

A conversion table has been included in this report. It offers a convenient way to convert between equivalent quantities of apples (in pounds, tons, or bushels), single-strength juice (in pounds or gallons), and concentrate (in pounds, gallons, or drums). This conversion table assumes juice at 12.5 percent solids and concentrate at 71 percent solids.

For the cost estimate, the plant is assumed to operate for two 8-hour shifts, or 16 hours per day, for 5 days a week. A total annual production season of 32 weeks or 160 operating days has been assumed (approximately an 8-month season).

On the daily basis, it was assumed that 14 hours of production would be obtained (14,000 gallons of single-strength juice per day) with 2 hours devoted to startup, shutdown, and cleaning operations.

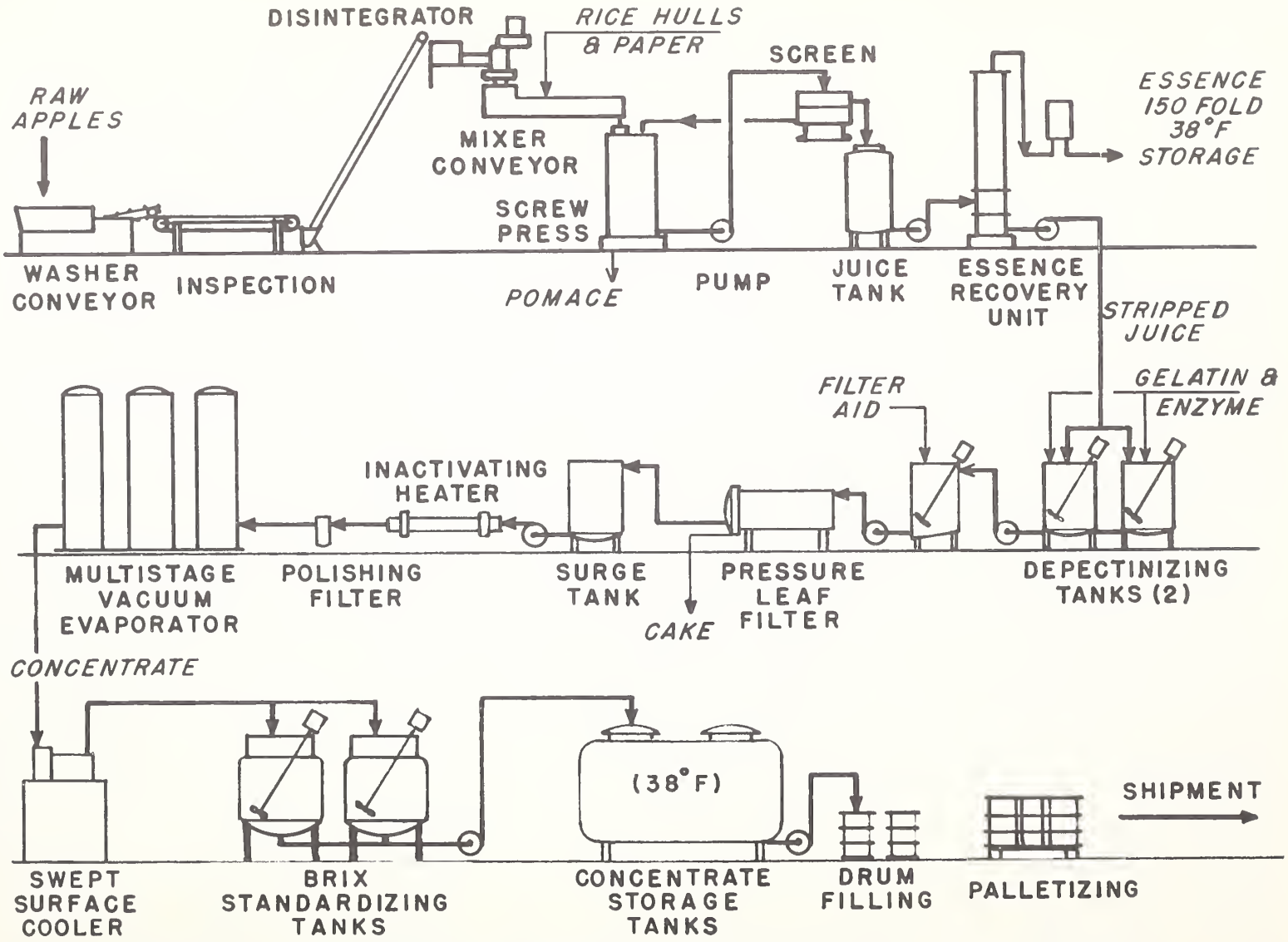

Figure 1. Processing steps in manufacturing applejuice Concentrate and Essence.

PROCESSING EQUIPMENT AND BUILDINGS REQUIRED

A list of the equipment required with a brief description of each item and its estimated price at the vendor's plant is given below.

Equipment

1.	Forklift trucks. Two: one for handling drums, one for moving containers of raw apples, $7,000 each	$14,000
2.	Dumper for apple bins	2,000
3.	Water-filled concrete pit into which apples are dumped for washing	3,000
4.	Elevator to lift apples from washing pit	1,800
5.	Washing and inspection conveyor-powered rollers and water sprays	2,000
6.	Equipment purchased as a "package" unit, from discharge of inspection conveyor to discharge of apple press. Includes screw conveyor, disintegator, handling and metering equipment for pressing aids, paper chopper, etc., with automated controls	70,000
7.	Pomace conveyor system	2,500
8.	Vibrating screen for screening solids from juice, 100 to 150 mesh	2,100
9.	Juice-feed tank for essence recovery unit, 300-gallons SS (stainless steel)	1,200
10.	Essence recovery unit	15,000
11.	Essence receiving and holding tank, 100-gallon, SS, jacketed	1,800
12.	Essence pump, SS	250
13.	Stripped juice pump	700
14.	Depectinizing tanks. Two, Agitated, SS, 3,000 gallons each @ $4,200	8,400
15.	Pump for depectinized juice	700
16.	Filter-feed tank (same type as item 14)	4,200

17.	Pressure-leaf filter, SS, 180 square feet of filtering area	$13,000
18.	Holding tank for filtrate. SS, 1,000-gallon, open top	1,600
19.	Inactivating heater for juice (to destroy pectinase enzyme)	1,200
20.	Polishing filter (to remove any solids before evaporator)	2,000
21.	Vacuum evaporator (to evaporate 6,400 pounds of water per hour)	60,000
22.	Swept-surface cooler, to cool concentrate from evaporator	5,200
23.	Brix standardizing tanks. Two, 250-gallon, jacketed for cooling, agitated	8,500
24.	Concentrate pump	800
25.	Concentrate storage tanks. Three, 40,000 gallons each. Horizontal type, epoxy-lined carbon steel. Located within refrigerated rooms, $18,000 each	54,000
	Total	$275,950

Other Facilities

1.	Refrigeration room for concentrate storage tanks. Size 40 by 70 by 20 feet high	$ 57,500
2.	Refrigeration system, 15 tons, installed	18,600
	Total	$ 76,100

Buildings

1.	Processing and storage, 5,000 square feet @ $16.50 per square foot	$ 82,500
2.	Boiler room, 600 square feet @ $16.50	10,000
3.	Refrigeration room (as above)	57,500
	Total	$150,000

While not originally included in the list of equipment, a clean-in-place system for cleaning and sanitizing process equipment may well be worthwhile. Such equipment is likely to give more consistently effective cleaning than will the use of entirely manual cleanup. The effect of the additional cost of this equipment on product selling price will be minimal.

FIXED CAPITAL COST

The following tabulation provides an estimate of the main items of fixed capital cost in addition to the processing equipment.

1.	Land and site preparation		$ 10,000
2.	Buildings		150,000
3.	Utilities:		
	Refrigeration system	(18,600)	
	Boiler (6,000 pounds of steam per hour)	(40,000)	58,600
4.	Processing equipment		276,000
5.	Equipment installation		26,000
6.	Piping		21,000
7.	Insulation		10,000
8.	Electrical		21,000
9.	Instrumentation		12,000
10.	Freight on equipment		5,400
11.	Office equipment		5,000
	Total physical plant		$595,000
12.	Contractor's fee		40,000
13.	Engineering costs		55,000
14.	Contingency allowance		60,000
	Total fixed capital cost -		$750,000

WORKING CAPITAL

Working capital is accounted for chiefly as inventories and accounts receivable. As an approximation, the average working capital requirement over a calendar year will be taken as equal to 2 months' sales, or $200,000.

PLANT OPERATING COSTS

To obtain the cost of operating the plant, all cost items are itemized and listed individually on the operating cost form (table 1). This cost form is filled out on the basis of costs for one operating day. The annual cost for any individual item is thus its daily cost as shown, multiplied by 160, the number of operating days per year. Individual cost items are also listed as "cents per gallon of 71° Brix concentrate." This figure is obtained by dividing the cost per day, in dollars, by the number of gallons of concentrate produced each day (1,904), and then converting the result to cents.

Some items, such as real estate taxes, insurance, and maintenance and repair, were first computed on an annual basis. These were then converted to a daily basis by dividing by 160.

Depreciation was calculated by the straight-line formula. As an alternative, one could choose an accelerated depreciation method that would give a different value for annual depreciation each year, with the early years being higher. This would yield a greater cash flow (that is, the sum of annual depreciation plus net profit after taxes) in the early years and result in faster payback of fixed capital investment.

TABLE 1.--Operating costs

[Conditions assumed: 2 shifts--16 hours per day: 14 hours production, 2 hours cleanup. Operations 5 days per week, 32 weeks a year; total 160 operating days per year. One thousand gallons of juice per operating hour (14 hours per day); 1,904 gallons of concentrate per day.]

Item	Cost per day	Cost per gallon of concentrate
	Dollars	Cents
Factory manufacturing costs:		
Direct production costs:		
Raw materials:		
Apples-- 3,880 bu/day @ $1/bu - - - - - - - - - - - - - - -	3,880.00	203.78

TABLE 1.--Operating costs--Continued

Item	Cost per day	Cost per gallon of concentrate
	Dollars	Cents
Paper pulp-- 1¼ percent of apple weight; 2,183 lb @ 9¢/lb	196.43	10.32
Rice hulls-- 2,183 lb/day @ 8 3/4¢ lb	191.01	10.03
Depectinizing enzyme-- 4 lb/3,000-gal juice; 18.67 lb/day @ $1/lb	18.67	.98
Gelatin-- 70 oz/3,000-gal juice; 20.42 lb/day @ 50¢/lb	10.21	.54
Filter aid-- 600 lb/day @ 6¢/lb	36.00	1.89
Total raw materials	4,332.32	227.54
Packaging materials:		
Reconditioned 55-gal drums for concentrate: includes drum, plastic liner, label, use of returnable pallet, strapping. 34.62 drums/day @ $6.40/drum	221.57	11.64
Essence: Plastic gallon jug, closure, label, carton. 93 1/2 gal/day @ 30¢/gal (150-fold)	28.00	1.47
Total packaging materials	249.57	13.11

TABLE 1.--Operating costs--Continued

Item	Cost per day	Costs per gallon of concentrate
	Dollars	Cents
Operating labor:		
4 operators/shift; 2 8-h shifts/day @ $3.25/h - - - - - - - - - - - - -	208.00	10.92
Indirect labor:		
2 shift supervisors @ $3.75/h. The following are employed on year-round basis; daily cost is total annual salaries divided by 160: Mechanic @ $7,280/year, shipping and receiving man @ $6,760, office manager @ $7,500, secretary @ $5,000.	60.00	3.15
Total for 4: $26,540/year - - - - - - - - - -	166.88	8.76
Total indirect labor: - - - - - - - - - - - -	226.88	11.91
Maintenance and repairs:		
Assume 3 percent per year of fixed capital - - - - - - - -	140.63	7.39
Operating supplies:		
Assume 8 percent of maintenance and repairs - - - - - - - - - - -	11.25	.59

TABLE 1.--Operating costs--Continued

Item	Cost per day	Costs per gallon of concentrate
	Dollars	Cents
Utilities:		
Steam: 90,000 lb/day @ $1.50/1,000 lb	135.00	7.09
Electricity: 1,250 kwh/ day @ 2.0¢	25.00	1.31
Fuel: for forklift trucks	1.00	.05
Water: 200 gal/min, 200,000 gal/day @ 25¢/1,000 gal	50.00	2.63
Total utilities	211.00	11.08
Total direct production costs	5,379.65	282.54
Fixed charges:		
Insurance: 1% per year of fixed capital	46.88	2.46
Real estate taxes: 1¼ percent per year of fixed capital	58.59	3.08
Depreciation:		
12-year life on equipment, 33 yr on buildings	337.59	17.73
Total fixed charges	443.06	23.27

TABLE 1.--Operating costs--Continued

Item	Cost per day	Costs per gallon of concentrate
	Dollars	Cents
Plant overhead costs:		
Nonwage payments: social security, workmen's compensation, unemployment insurance, hospitalization, vacation: assume $1/h for each employee (actual time worked)	112.00	5.88
Miscellaneous factory expenses	10.00	.53
Total plant overhead costs	122.00	6.41
Grand total, factory manufacturing costs	5,944.71	312.22
General expenses:		
Interest on working capital @ 8% (av. working capital over year: ($200,000)	100.00	5.25
Research and development @ $500/yr	3.13	.16
Administration and general $12,000/yr	75.00	3.94
Total general expenses	178.13	9.35

TABLE 1.--Operating costs--Continued

Item	Cost per day	Costs per gallon of concentrate
	Dollars	Cents
Cost to make	6,122.84	321.58
Selling cost. Assume 7 percent of selling price	545.72	28.66
Profits and discounts:		
Returns, allowances, discounts: 0.5 percent of sales	38.98	2.05
Profit (net after taxes): 12% per year on original fixed capital ($750,000)	562.50	29.54
Taxes on income, State and Federal	526.01	27.63
Total selling price	7,796.05	409.46
Sales of essence, 93 1/3 gal/day at $8/gal	746.67	39.22
Sales of concentrate, 1,904 gal/day (by difference)	7,049.38	370.24

Taxes on net income before taxes were calculated to include both State (Michigan) and Federal corporation income taxes. The rates used were 7.8 percent of net income before taxes for Michigan tax and 22 percent of the first $25,000 of taxable income and 48 percent of the remaining taxable income for Federal tax. State taxes were subtracted from "net income profit before taxes" before computing the Federal tax on the reaminder.

Net profit after taxes was arbitrarily selected at this point as 12 percent per year on original fixed capital to compute a selling price for the concentrate. This amounts to $90,000 per year net profit after all expenses and taxes. Any other desired percentage could, of course, have been selected.

For the assumptions and data that were used in the operating cost computations, the selling price of the concentrate, in 55-gallon drums, was 370.24 cents per gallon, or $3.70. This assumes that the essence produced can be sold at $8 a gallon (early 1973 price). Daily production of essence is 93 1/3 gallons, with a daily value (at $8) of $746.67.

If essence sells at a price other than $8 a gallon, the concentrate price would have to be adjusted to maintain the same net profit. For each change in essence price of $1 per gallon, up or down, the concentrate price would change about 5 cents per gallon. Thus, if essence sold at $10, concentrate could be sold at $3.60; and with essence at $6, concentrate would have to sell at $3.80 to maintain 12-percent net return on fixed capital.

A more condensed and more readily understandable version of the operating cost sheet items is given in table 2.

TABLE 2.--Operating costs (condensed form)

Item	Cost per gallon of concentrate
	Cents
Raw materials:	
Apples @ $1/bu	203.8
All other	23.8
	227.6
Packaging materials for both essence and concentrate	13.1
All employees:	
Direct wages and salaries	22.8
Fringe benefits	5.9
	28.7
Maintenance, repair, supplies, miscellaneous factory expense	8.5

TABLE 2.--Operating costs (condensed form)--Continued

Item	Cost per gallon of concentrate
	Cents
Utilities	11.1
Fixed charges:	
Local taxes and insurance	5.5
Depreciation	17.7
	23.2
General expenses:	
Interest on working capital	5.2
Research and development	.2
Administrative and general	3.9
	9.3
Selling expenses	28.9
Returns, allowances, discounts	2.0
Corporate income taxes	27.6
Net profit (12 percent of fixed capital per year)	29.5
Total	409.5
Value of essence produced per gallon of concentrate (at $8 per gallon of essence)	39.2
Selling price of concentrate per gallon-	370.3
Total	409.5

FINANCIAL ANALYSIS

The financial analysis presented here is a summary of the important dollar amounts involved in the cost estimate, on an annual basis, using the conditions and assumptions discussed. These conditions include buying apples at $1 a bushel and selling concentrate at $3.70 a gallon and essence at $8 a gallon. The net profit rate assumed was 12 percent a year on fixed capital investment. Obviously, if the going price for concentrate is more than $3.70, the manufacturer will sell at the market price, earning a higher return on investment.

Gross sales:		
Concentrate (304,640 gal @ $3.70 gal)		$1,127,900
Essence (14,933 gal @ $8 gal)		119,467
Total		1,247,367
Returns, allowances, discounts:		
1/2 percent of gross sales		6,237
Net annual sales		1,241,130
Production cost (factory manufacturing expense) $5,944.71 x 160 days		951,154
Gross annual profit		289,976
Other expenses:		
Administrative and general	12,000	
Research and development	500	
Interest on working capital	16,000	
Selling expenses	87,315	
Total other expenses		115,815
Net income profit before taxes on income		174,161
Taxes on income, Federal and State		84,161
Net annual earnings after taxes		90,000
Earned on fixed capital ($750,000) - - percent - -		12.0

Cash flow (annual):

Depreciation	$54,014
Net earnings	90,000
Total cash	$ 144,014

Payout time:

For fixed capital of $750,000 (÷ 144,014) - years	5.2

Under the conditions assumed, the annual "cash flow," which is the sum of depreciation set-aside and net profit after taxes, is $144,000. Dividing this amount into the fixed capital investment of $750,000 gives 5.2 years for recovery of the fixed capital investment.

The data below provide a summary of an applejuice concentrate plant.

	Per hour	Per day	Per year
Input to plant (raw apples or equivalent):			
Pounds	12,500	175,000	28,000,000
Bushels	278	3,890	622,720
Tons	6.25	87.5	14,000
Output:			
Concentrate (gallons)	136	1,904	304,640
Essence (150-fold) (gallons)	6.67	93.3	14,933

Selling price in dollars per gallon (to yield a 12 percent annual return on fixed capital investment):

Concentrate	$3.70
Essence	8.00

Annual sales (dollars):

Concentrate	1,127,900
Essence	119,460
Total	$1,247,360

Investment:

Fixed capital:

Purchased equipment	$276,000
Land and buildings	160,000
Utilities	58,600
Installation, wiring, piping, insulation, etc.	100,400
Engineering, contractor's fee, contingencies	155,000
Total	$750,000
Working capital	200,000
Startup expenses	40,000
Total investment	$990,000

An estimated $40,000 is allotted as a startup expense to cover operating expenses during the first few weeks of operating the new plant. This money will cover correcting any defects in equipment or operating procedures before satisfactory operation, and acceptable products, can be achieved. These startup expenses can be largely offset, under present Federal income tax laws, by the tax credit on new plant investment. This is an offset against taxes of 7 percent of the cost of "qualifying" new equipment. Credit for this investment tax offset was not taken elsewhere in this estimate.

The total estimated capital required, namely, the sum of fixed capital, working capital, and startup expenses, is slightly under $1 million. This assumes the use of all new plant and facilities exclusively. The use in part of existing facilities or lower cost secondhand equipment or both would reduce the capital cost and, for the same selling price for concentrate, raise the return on investment.

A decrease of 10 percent ($75,000) in fixed capital cost would decrease the selling price of concentrate needed to earn a 12 percent return by about 10 cents a gallon, or from the calculated $3.70 down to $3.60. If, however, the price of concentrate were maintained at $3.70 a gallon, the net profit would increase. The combined effect of the larger net profit and the smaller fixed capital investment would, in this instance, raise the return on fixed capital from 12.0 to 15.5 percent a year.

The effect on net profit and percent return on investment of various prices for concentrate and for raw apples is discussed in the following section.

BREAK-EVEN SELLING PRICE FOR CONCENTRATE VERSUS PRICE OF RAW APPLES

It cannot reasonably be expected that prices for apple concentrate, which in early 1973 were at or near their alltime highs, will remain at these levels indefinitely. As new producing facilities come into operation, either in the United States or abroad, or both, and supplies become more plentiful, prices should drop. Also if the demand for concentrate should slacken, prices will likely drop. Therefore, in planning a concentrate plant, the owners should know the lowest price at which the concentrate could be sold without losing money, or the break-even price. At this price, the plant would neither earn nor lose money at the assumed output rate of 304,640 gallons per year. The break-even price, of course, depends on the price that the plant has to pay for apples.

Table 3 shows, for various prices paid for apples fed to the concentrate plant, the price at which the concentrate would have to sell for the plant to break-even. At such prices the plant makes no profit and also pays no income taxes. The plant would still have a cash flow consisting of the annual depreciation figure but would have zero earnings on fixed capital. Interest on working capital, as well as all other expenses except any return on fixed capital, would be covered. Thus, these selling prices for concentrate are the minimum that could be experienced without operating at a loss. This table assumes the production and sales of concentrate per year of 304,640 gallons and the selling price of essence (150-fold) at $8 a gallon. Each change in essence price of $1 would change the break-even price for concentrate by about 5 cents.

TABLE 3.--Break-even prices for concentrate versus price of raw apples

Price paid for apples			Break-even selling price per gallon of concentrate
Per ton	Per bushel	Per hundredweight	
Dollars	Dollars	Dollars	Dollars
15	0.34	0.75	1.60
20	.45	1.00	1.85
25	.56	1.25	2.10
30	.68	1.50	2.35
35	.79	1.75	2.60
40	.90	2.00	2.85
45	1.01	2.25	3.10
50	1.13	2.50	3.35
55	1.24	2.75	3.61
60	1.35	3.00	3.86

PROFITABILITY VERSUS PRICES FOR CONCENTRATE AND RAW APPLES

The profitability of the plant will vary as costs change. The two chief cost items that affect profitability are the selling price of concentrate and the price paid for raw apples. While keeping all other assumed conditions and costs constant, various combinations of apple and concentrate prices were selected and profit figures were computed. These data are given in table 4.

The price of concentrate in the table varies from $2.50 to $4.50 a gallon and the cost of apples from $20 to $70 a ton. Percent earned annually on a fixed capital investment of $750,000 ranges from 3.2 to 30.1 percent Of course, lower fixed capital investment would result in a higher percent return on investment, and vice versa. Table 4 is based also on selling essence at $8 a gallon. A drop of $1 a gallon in essence price would necessitate an approximately 5 cents per gallon increase in concentrate price to maintain the same net income.

TABLE 4.--Profitability of concentrate plant versus selling price of concentrate and price paid for raw apples

Selling price per gallon of concentrate[1/]	Gross sales, concentrate plus essence per year	Price paid for apples per ton	Total cost of apples per year	Net profit before income taxes per year	Income taxes per year	Net profit after taxes per year	Percent return on fixed capital investment of $750,000 per year
Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	
2.50	881,066	20.00	280,000	180,855	87,646	93,209	12.4
		30.00	420,000	40,855	14,767	26,088	3.5
3.00	1,033,387	20.00	280,000	319,801	159,976	159,825	21.3
		30.00	420,000	179,802	87,098	92,704	12.4
		40.00	560,000	39,802	14,219	25,583	3.4
3.50	1,185,706	30.00	420,000	318,747	159,427	159,320	21.2
		40.00	560,000	178,747	86,549	92,198	12.3
		50.00	700,000	38,747	13,670	25,077	3.3
3.70[2/]	1,247,366	44.44[3/]	622,200	174,162	84,162	90,000	12.0
4.00	1,338,026	30.00	420,000	457,693	231,829	225,864	30.1
		40.00	560,000	317,693	158,859	158,834	21.2
		50.00	700,000	177,693	85,989	91,704	12.2
		60.00	840,000	37,693	13,119	24,574	3.3
4.50	1,490,346	40.00	560,000	456,640	231,209	225,431	30.1
		50.00	700,000	316,640	158,330	158,310	21.1
		60.00	840,000	176,640	85,452	91,188	12.2
		70.00	980,000	36,640	12,573	24,067	3.2

1/ 304,640 gallons of concentrate a year; also 14,933 gallons of essence selling at $8 a gallon or $119,460 a year.

2/ This line represents the conditions of the calculations on the operating cost sheets (table 1).

3/ $1 per bushel.

EFFECT OF OPERATING THE PLANT AT REDUCED CAPACITY--BREAK-EVEN POINT

In a given season the plant possibly would operate at less than the capacity assumed in this estimate for such reasons as follow:

- A shortage of apples for juicemaking because of a short crop year.
- Prices for juice apples so high during part of season, compared with market price of concentrate, as to make their purchase unprofitable.
- Strikes or labor disputes.
- Serious equipment breakdowns causing extended plant shutdown.
- Natural disaster, such as flood or tornado, disrupting plant operations.

Whatever the cause, operation at only part of the assumed annual capacity would reduce income and net profit because at reduced capacity, income drops faster than expenses. Part of the expenses will decrease as output decreases, such as expenditures for apples, filter aid, and drums, but part will continue at the same level--real estate taxes, insurance, depreciation, and others. Thus, as capacity falls off, eventually expenses (on the annual basis) just equal income from sales (also on the annual basis). At this capacity level, there is no profit or loss; this is the break-even point. Below this percentage of annual capacity, the plant will operate at a loss for the season. Table 5 gives the calculations for the break-even point, and the results of these calculations are also shown in figure 2. On the right-hand side of the chart, sales income exceeds total expenses, including taxes, and the plant operates at a profit. On the left-hand side of the chart, costs are higher than sales, and the plant operates at a loss. At about 41 percent of capacity over the season, the plant will approximately break even for the year.

The specific dollar figures shown plotted on figure 2 apply accurately only under the specific conditions assumed for the estimate made on the operating cost sheets (table 1). Actual conditions will vary, especially the selling prices for concentrate and essence and the cost of raw apples. Thus, the break-even point of annual capacity could be higher or lower than 41 percent. In general, when the plant is making higher net profit per gallon than the 29.5 cents shown on the operating cost sheet (which corresponds to a 12 percent return on fixed capital of $750,000), the break-even point will be lower; that is, the plant can run at less than 41 percent of annual capacity over a season and still break even. When profit per gallon is lower than that yielding a 12 percent return on fixed capital, the plant would have to run at a higher average annual capacity over the season than 41 percent in order to break even for the year.

TABLE 5.--Calculation of break-even point

[Percentage of production capacity at which plant would operate at neither a profit nor a loss. For the calculations in this table, the same conditions and costs are assumed as for the plant version given in table 1. Figures in parentheses denotes loss.]

Percentage of plant annual capacity 1/	Gallons of concentrate per year	Annual sales 2/ per year	Fixed costs per year	Variable costs 3/ per year	Total annual costs per year except profits & taxes	Net profit per year before income taxes	Income taxes per year State and Federal	Net profit per year after taxes	Percent annual return on fixed capital 4/	Total per year of costs including taxes
		Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars		Dollars
0	0	0	123,211	0	123,211	(123,211)	5/	6/	7/	123,211
20	60,928	249,473	123,211	189,998	313,209	(63,736)	5/	6/	7/	313,209
40	121,856	498,946	123,211	379,996	503,207	(4,261)	5/	6/	7/	503,207
42	127,949	523,893	123,211	398,996	522,207	1,686	473	1,213	0.2	522,680
45	137,088	561,312	123,211	427,495	550,706	10,606	2,979	7,627	1.0	553,684
50	152,320	623,682	123,211	474,995	598,206	25,476	7,155	18,321	2.5	604,968
60	182,784	748,419	123,211	569,994	693,205	55,214	22,242	32,972	4.4	715,447
80	243,712	997,892	123,211	759,991	883,202	114,690	53,203	61,487	8.2	936,405
100	304,640	1,247,365	123,211	949,989	1,073,200	174,160	84,161	90,000	12.0	1,157,361
125	380,800	1,559,206	123,211	1,187,487	1,310,698	248,500	122,859	125,641	16.8	1,433,557

1/ "Normal" plant capacity taken as 304,640 gallons of concentrate per year.

2/ Includes essence sales at same percentage of annual capacity as for concentrate.

3/ Variable costs are 311.84 cents per gallon of concentrate.

4/ Fixed capital of $750,000.

5/ Partial refund.

6/ Loss.

7/ Negative.

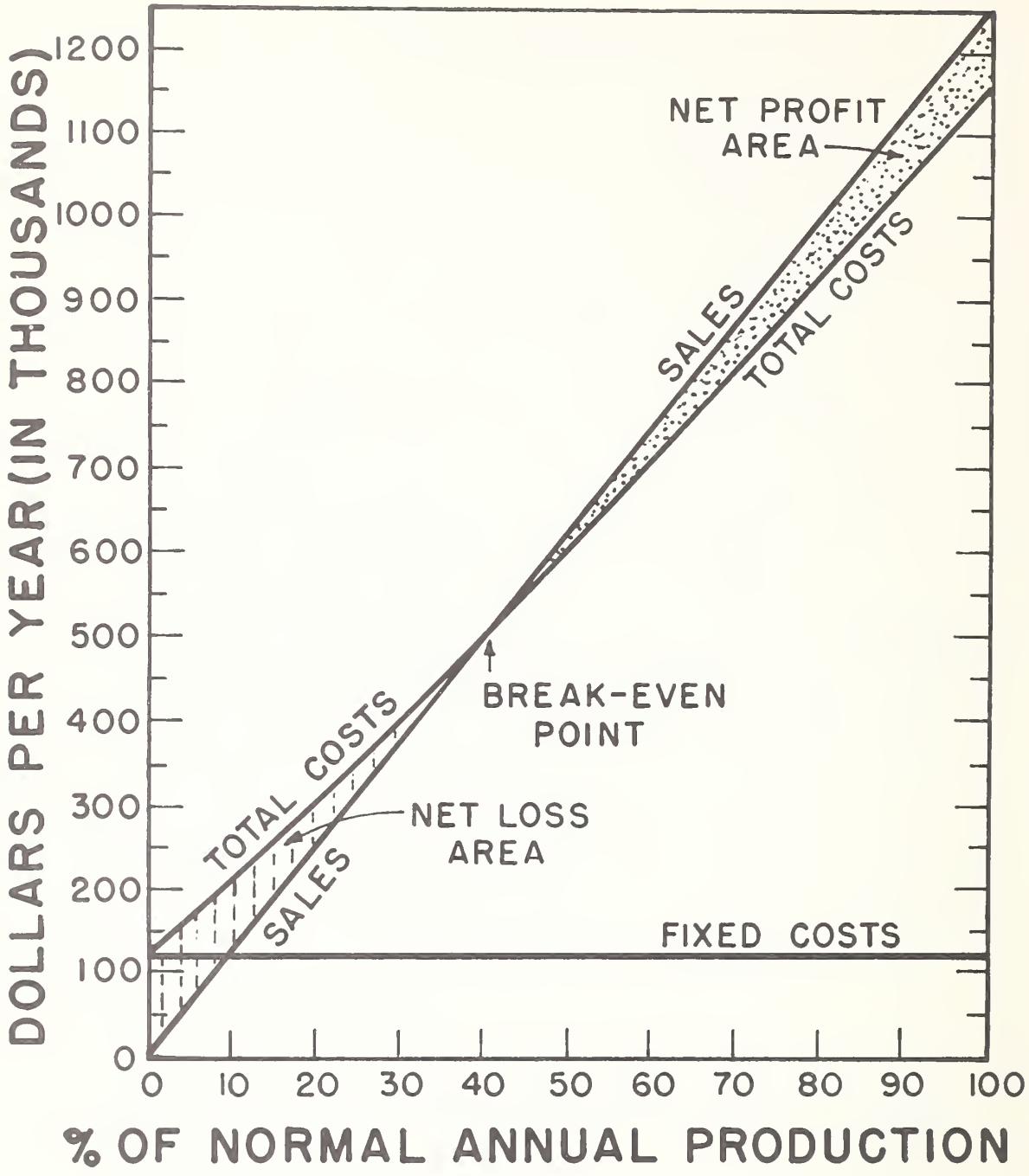

Figure 2. Calculations for the break-even point.

If the demand for concentrate is strong and the supply of apples is adequate, the plant possibly can run with higher output over a season than its assumed "normal" output. Since plant operations were assumed at 16 hours per day, output could be increased readily by adding a third shift. Table 5 shows one line for an assumed production of 125 percent of normal and shows an appreciable increase in the percent return on fixed capital as a result

OPERATION OF PLANT USING ADDITIONAL FRUITS

While the plant is designed to operate on apples, it could also be used, with minor modifications, to produce concentrate and essence from such other fruits as red sour cherries, blackberries, raspberries, strawberries, and Concord grapes. The last-named would conflict in its operating season with apples, but the others would be in season before the apple crop. Of course, a sufficient nearby supply of a particular fruit and an adequate price for the concentrate and essence products would be necessary to make the processing economically worthwhile.

The extension of the operating season by processing one or more additional fruits would have the advantage that fixed costs would be spread out over a greater quantity of production. Thus, the fixed costs per gallon of apple concentrate produced would be reduced.

A number of publications are available on the processing requirements for making concentrate and essence from different fruits and berries.3/

3/ Aceto, N. C., Eskew, R. K., and Phillips, G. W. M. High-density, full-flavor cherry juice concentrates. The Glass Packer 32(9): 54. September 1953.

Claffey, J. B., Eskew, R. K., Eisenhardt, N. H., and Aceto, N. C. An improved experimental unit for recovery of volatile flavors. U. S. Agr. Res. Serv. ARS 73-19, 8 pp. 1958. (Revised 1972.)

Eisenhardt, N. H., Eskew, R. K., Claffey, J. B., and Aceto, N. C. The preparation of full-flavor berry juice concentrates. U. S. Agr. Res. Serv. ARS 73-20, 7 pp. 1958.

Eskew, R. K., Redfield, C. S., Eisenhardt, N. H., Claffey, J. B., and Aceto, N. C. High-density full-flavor grape juice concentrate. U. S. Agr. Res. Serv. AIC-342, 15 pp. 1 p. sup. 1952. (Reprinted 1957.)

LEGAL REQUIREMENTS

The establishing of plants that produce fruit juice concentrate and essences within the United States is subject to regulations of the Internal Revenue Service, United States Department of the Treasury. Publication 189 of that agency, entitled "Production of Volatile Fruit-Flavor Concentrates," contains details of the applicable regulations and is available from district offices of the Internal Revenue Service. Prospective manufacturers of applejuice concentrate and essence are advised to contact the Alcohol, Tobacco, and Firearms Division of the Internal Revenue Service before setting up a manufacturing plant, and to familiarize themselves with the applicable rules and regulations governing the operation of such a plant.

CONCLUSIONS

The estimate indicates that as of January 1973, a new plant to make high-density applejuice concentrate and essence, built with all new, up-to-date equipment, should be profitable.

The estimate is for a plant sized to produce and process 1,000 gallons an hour of single-strength applejuice into high-density (71° Brix) applejuice concentrate and 150-fold apple essence, starting from raw apples.

At early 1973 prices for concentrate, essence, and raw apples, the plant when operated at its estimated capacity should earn an approximately 17 to 20 percent annual return on a fixed capital investment of $750,000, while paying an 8 percent interest rate on borrowed working capital of $200,000. These figures are based on concentrate selling at $4.25 to $4.50 a gallon, essence at $8 a gallon, and raw apples at $2.25 to $2.50 a hundredweight. Under these conditions, net profit earned after taxes would be approximately $130,000 to $150,000 a year. Added to this figure would be before-tax depreciation income of $54,000 a year by the straight-line formula, or somewhat higher (in the early years) if accelerated depreciation is used to reduce income taxes in the early years of plant operation.

Extension of the plant's operating season by processing other fruits besides apples would reduce the fixed costs per gallon of apple concentrate produced.

CONVERSION TABLE

Equivalent quantities of raw whole apples, applejuice pressed from the apples, and concentrate made from the juice

Figures given are approximate and are based on the following data:

1. Brix of raw juice assumed to be 12.5° Br. (= % solids). Specific gravity of juice = 1.0505 at 68° F; therefore, 1 gallon of juice = 8.33 X 1.0505 lb = 8.75 lb. One gallon of juice contains 8.75 X 0.125 = 1.09375 lb of solids.

2. Brix of concentrate assumed to be 71° Br; specific gravity then = 1.3563, and weight of concentrate = 8.33 X 1.3563 = 11.30 lb per gallon. One gallon of concentrate contains 11.30 X 0.71 = 8.023 lb of solids.

3. One ton = 2,000 lb; 1 bushel of apples = 45 lb.

4. Yield of juice from apples = 160 gallons per ton, = 160 X 8.75 = 1,400 lb juice per ton of apples; or a 70 percent yield of juice by weight from the raw apples.

Directions for use of table: Read horizontally across any one line to find equivalent quantities.

Examples:

1. To find quantities equivalent to 1 ton of apples, read down "Apples-Tons" column to 1.0. Going horizontally on this line, we find 1.0 tons of apples is equivalent to 160 gallons of juice, to 21.8 gallons of concentrate, etc.

2. Similarly, under "Concentrate, 55-gallon drums" we find that 1.0 drum is equivalent to 2.522 tons of apples, or 112 bushels.

Juice		Apples			Concentrate		
Gallons	Pounds	Tons	Bushels	Pounds	Pounds	Gallon	55-gal. drums
1.0	8.75	0.00625	0.278	12.5	1.54	0.136	0.0025
.114	1.0	.00071	.0318	1.43	.176	.0155	.00028
160	1,400	1.0	44.4	2,000	246.5	21.8	.396
3.60	31.5	.0225	1.0	45	5.55	.491	.00893
.080	.7	.0005	.0222	1.0	.1232	.0109	.0002
.649	5.68	.00406	.1803	8.11	1.0	.0885	.00161
7.335	64.18	.04585	2.037	91.7	11.3	1.0	.0182
403.4	3,530	2.522	112.0	5,044	621.5	55.0	1.0

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