Apples - Packing

ECONOMICS INFORMATION REPORT

APPLE PACKING COSTS

E. A. Proctor
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ABSTRACT

The purpose of this report is to determine the comparative costs of packing apples in modern North Carolina plants for a range of output capacities, lengths of season and technologies. Information on investment and operating costs was obtained from packinghouse operators, equipment manufacturers and published research reports. These data are used to derive fixed and variable costs per unit of output for the different plants.

Building, equipment for either manual or mechanical dumping systems, and operating costs are determined for packinghouses with hourly output capacities of 100, 200, 300, 400, 600 and 800 boxes of 40 pounds each. Total season costs are provided for the 200- and 400-box capacities for 300- and 400-hour seasons to illustrate length of season effects and procedure.

Results of the study indicate that output increased 100 percent by increasing capacity from 200 to 400 boxes/hour, with a 50 percent increase in capital investment. Annual costs per box decrease $ .09 when capacity is increased from 200 to 400 boxes per hour for a 300-hour season and $ .06 when length of season is increased from 300 to 400 hours for the 400-box plant. The cost decrease when both length of season and size of plant are increased is $ .15 per box. This information should benefit the N. C. packing industry as it considers future organization of resources for the purpose of maintaining or increasing its competitive position.

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APPLE PACKING COSTS

E. A. Proctor and E. A. Jackson*

Introduction

Economic returns from increasing supplies of North Carolina apples have been adversely affected by the increasing supplies of apples in the United States and in other nations. Prices of North Carolina apples are probably as responsive to changes in United States supplies, particularly in the eastern states, as they are to changes in North Carolina supplies. Since these supply conditions and the resultant prices are expected to prevail for the foreseeable future, the apple industry has requested an analysis of alternatives which might halt or reverse these adverse effects.

Purpose

The purpose of this study is to provide information which the North Carolina industry can use to improve the efficiency of packing and the quality of apples, and thus partially offset lower prices in order for it to maintain or increase net returns. Size of firm and/or plant and the marketing systems vary considerably in the North Carolina industry. Some relatively small growers pack only the fruit produced on their own orchards and market over a long period to specialized outlets. Some other relatively small to large grower-packers assemble and pack for several other growers and market the fruit through major trade channels.

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Previous studies of the industry which involved the economies-to-scale principle indicated that organization of the packing industry into more efficient sized units would provide for better quality fruit packed at lower cost. The remainder of this study reports an analysis of the capital investment and operating costs of a range of packinghouse sizes capable of servicing known trade channels and maximizing packing efficiency.

Procedure

The building, equipment and operating costs were determined for packinghouses with hourly output capacities of 100, 200, 400, 600 and 800 boxes of 40 pounds each.[1] The economic-engineering procedure[2] was used to synthesize building, equipment and operating costs for each of these packinghouses. An example was also developed to illustrate how total season costs may be determined for given season lengths. For the example, packinghouses with hourly output of 200 and 400 boxes operating for 300- and 400-hour seasons were used.

Operating packinghouses were visited and information was obtained on plant construction, equipment, supplies and labor force required for operation of plants incorporating current technology. Prices of inputs were obtained from manufacturers and existing packinghouses.[3] Input

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[1]The basic sources of data were: Planning Data for Marketing Selected Fruits and Vegetables in the South, Part III, Fresh Vegetable Packing Handbook, Southern Cooperative Series Bulletin No. 152, May 1970, and Hoy F. Carmon, An Analysis of Apple-Packing Costs in Michigan, Marketing Research Report No. 786, U. S. Department of Agriculture, Washington, D. C., March 1967. However, these data were supplemented with data from sources indicated in footnote 3.

[2]This method has been used in many studies, e.g., Gene A. Mathia and Richard A. King, Planning Data for the Sweet Potato Industry, 4 Costs and Returns from Curing, Storing, Grading and Packing Sweet Potatoes, A. E. Information Series 108, and R. J. Peeler, Jr., and Richard A. King, In-Plant Costs of Grading and Packing Eggs, A. E. Information Series 106, Department of Economics, N. C. State University, Raleigh, 1963.

[3]The authors are grateful to the following manufacturers, distributors and packinghouse owners for information without which this study would have been more difficult:

FMC Corporation, Lakeland, Florida
Durand Machinery, Inc., LaGrange, Georgia
Nun Henderson & Son, Hendersonville, N. C.

prices for previous years were adjusted to estimate 1970 prices by comparing with price changes in similar equipment. Land and site preparation costs are not included because of locational variability.

Packinghouse Production Line

The typical packinghouse production line can be represented by the sequence of movements of fruit through work stations as shown in the flow chart. For most efficient operations, the production line should be laid out in either a straight or "L" shaped line to prevent cross traffic patterns. Thus, the design of the equipment line should be determined before a new building is constructed.

This study recognizes the importance of but does not include a detailed discussion of the technology of worker aids and techniques. However, since considerable gains in efficiency are possible with optimum use of technology and plant layout, readers may want to contact the Department of Economics and the Department of Biological & Agricultural Engineering, N. C. State University, Raleigh, N. C., for assistance. Equipment manufacturers also will provide assistance for planning facilities.

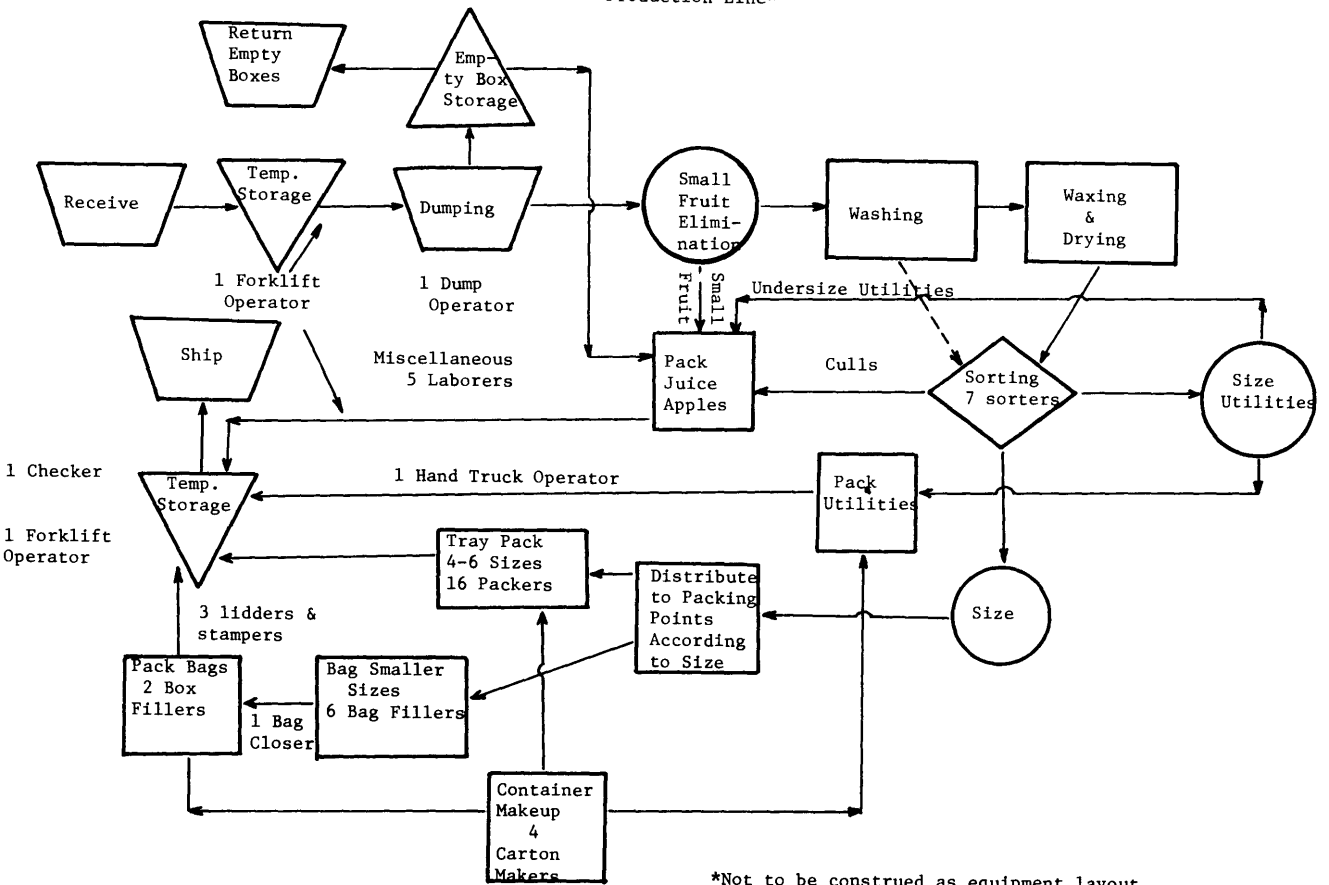
Buildings and Equipment

Buildings and equipment are classified as fixed costs which must be charged to the cost of packing apples in the long run whether or not the packinghouse is operated. However, these costs should not be included when determining the profitability of operating for any single packing season.

The selection of optimum size buildings and capacity machines or equipment is basic to the objective of operating a packinghouse at the lowest possible cost per packed unit (box, etc.). The information provided here may help accomplish this objective for those who anticipate construction of new buildings or remodeling and adding to existing buildings and for those who may be considering purchase of new equipment or replacement of old.

Mountain Crest, Inc., Hendersonville, N. C.
Leon Stepp, Dana, N. C.
Sugarloaf, Inc., Dana, N. C.
Latham & Jones Apple Packing House, Edneyville, N. C.
Western N. C. Apple Growers Coop., Hendersonville, N. C.

Flow Chart of Typical Apple Packinghouse Production Line*



*Not to be construed as equipment layout.

Size and Cost of Buildings

The shape and size of buildings may vary, depending upon individual circumstances as mentioned earlier. Owners of some existing buildings may find it expedient to add only one or more operating components to expand output or increase efficiency. The information provided in Table 1 attempts to accomodate a variety of such needs by specifying component operational spaces and costs for hourly packout capacities of 100, 200, 400, 600 and 800 boxes of apples.

The investment cost of each of the selected building capacities in Table 1 has been estimated by multiplying the space times price per square foot of each operating space and summing the results. These computations were performed for each building capacity and the results are presented at the bottom of Table 1. The per-unit cost advantage gained from increasing the size of the building is discussed in a later section.

Costs of Equipment

Information about the equipment installed in typical modern North Carolina packinghouses in 1970 and prices paid by operators or quoted by manufacturers was obtained by visits and interview. This information is presented in Table 2 for hourly packout capacities of 100, 200, 400, 600 and 800 boxes.

The receiving and dumping system specified as Alternate 1A, B and C employs typical field boxes, hand truck and manual dumping. Alternate 2A, B and C employs bulk boxes, fork lift truck and powered tilt dumper. Other items in Column A of Table 2 are self-explanatory. Columns B and C present the fruit load handled at different stations of the production line and rated capacities of equipment, respectively. The units in Column D refer to the number of items in Column A needed to obtain the hourly packout specified. Field boxes and bulk pallet boxes have been excluded from the table because of the wide variation in usage among North Carolina packinghouses. One packinghouse reported using 1,200 field and 50 bulk boxes; another reported 600 field and 100 bulk boxes. These boxes are used mainly for temporary storage of utilities. Producers furnish the boxes that are used to transport apples to the packinghouse. A typical cost reported for these boxes was $1.50 per field and $17.50 per bulk box. Those packinghouse operators who plan to use either box can use these prices

Table 1. Building requirements in relation to selected rates of output to receive, grade and pack apples[a]

Operation	Hourly packout (tray pack and bags)					1970 price per square foot[b]
	100	200	400	600	800	
	(square feet)					(dollars)
Receiving & dumping						
Platform	350	400	456	475	500	1.90
Main floor	360	450	575	1,150	1,150	5.00
Washing						
Main floor	120	150	250	500	500	5.00
Waxing & drying						
Main floor	340	525	725	1,050	1,450	5.00
Sorting						
Main floor	120	200	250	500	500	5.00
Packing						
Main floor	450	900	1,216	1,800	2,432	5.00
Bagging						
Main floor	250	300	310	600	620	5.00
Container makeup						
Loft	350	400	480	600	780	2.30
Conveying packed boxes						
Main floor	100	110	126	240	250	5.00
Temporary storage						
Main floor	525	840	1,680	2,100	2,520	5.00

Table 1 (continued)

Operation	Hourly packout (tray pack and bags)					1970 price per square foot[b]
	100	200	400	600	800	
	(square feet)					(dollars)
Office						
Main floor	240	240	240	360	360	5.75
Rest rooms						
Main floor	200	200	200	250	300	12.65
Break area						
Main floor	100	160	160	200	250	5.00
Aisles & unassigned						
Main floor	4,195	4,232	4,574	6,869	7,368	5.00
Total main floor	7,000	8,307	10,306	15,619	17,700	
Total cost	$38,180	$44,925	$55,210	$82,560	$93,809	

[a]Concrete and steel construction with wood office and rest rooms installed on main floor and loft above a portion of the floor.

[b]Cost per square foot includes all utilities. This is an estimated average cost. Cost per square foot will vary according to prevailing construction costs in the area.

Table 2. Equipment inputs in relation to selected rates of output to receive, grade and pack apples[a]

A	B	C	D					E
Operation and equipment item	Percent of packout handled	Hourly capacity (40# boxes)	Hourly packout (tray packs & bags) 40# boxes					Price per unit
			100	200	400	600	800	
			(units)					(dollars)
Receiving & dumping								
Alternate 1A - field boxes								
Hand truck	142	145	1	2	-	-	-	72
Dumpledge with aid	142	183	1	2	-	-	-	94
Receiving belt (30" x 5')	142	300	1	1	-	-	-	330
Alternate 2A - bulk boxes								
Fork lift truck	142	1,000	-	.5	1	1	1.5	9,610
Alternate 2A-1								
36" float dumper	142	300	-	1	-	-	-	3,700
48" float dumper	142	600	-	-	1	2	2	4,764
Roller conveyor (10')	-	-	-	2	-	-	-	265
Roller conveyor (15')	-	-	-	-	2	4	4	350
Alternate 2A-2								
Tilt type dumper	142	360	-	1	2	4	4	1,565
Receiving belt (36" x 6')	142	360	-	1	-	-	-	340
Receiving belt (48" x 7')	142	700	-	-	1	2	2	475
Small fruit elimination								
2 1/4 eliminator 24" x 3'	142	142	1	-	-	-	-	335
2 1/4 eliminator 36" x 3'	142	425	-	1	-	2	-	435
2 1/4 eliminator 48" x 3'	142	700	-	-	1	-	2	560

Table 2 (continued)

A	B	C	D					E
Operation and equipment item	Percent of packout handled	Hourly capacity (40# boxes)	Hourly packout (tray packs & bags) 40# boxes					Price per unit
			100	200	400	600	800	
			(units)					(dollars)
Washing								
14 roll washer 24"	135	185	1	-	-	-	-	1,940
14 roll washer 36"	135	360	-	1	-	-	-	2,276
23 roll washer 36"	135	480	-	-	-	2	-	2,713
23 roll washer 46"	135	660	-	-	1	-	2	3,449
Waxing								
Waxer 24"	135	330	1	-	-	-	-	1,880
Waxer 36"	135	500	-	1	-	2	-	2,084
Waxer 48"	135	720	-	-	1	-	2	2,342
Dryer 30" x 14'	135	180	1	-	-	-	-	5,934
Dryer 48" x 18'	135	420	-	1	-	2	-	8,694
Dryer 48" x 26'	135	570	-	-	1	-	2	10,697
Sorting								
Float roll sorting table								
24" x 6'	135	135	1	-	-	-	-	1,420
30" x 8'	135	270	-	1	-	-	-	1,938
36" x 10'	135	405	-	-	-	2	-	2,330
48" x 10'	135	540	-	-	1	-	2	2,708
Conveying cull and utilities								
Cull belt 6" x (ft.)	35	-	75	80	120	2@ 100	2@ 120	800 + 12

Table 2 (continued)

A	B	C	D					E
Operation and equipment item	Percent of packout handled	Hourly capacity (40# boxes)	Hourly packout (tray packs & bags) 40# boxes					Price per unit
			100	200	400	600	800	
			(units)					(dollars)
Packing culls and juice								
Alternate 1B								
Automatic field box filler	20	360	1	1	1	1	1	1,320
Alternate 2B								
Automatic bulk box filler	20	240	-	1	1	1	1	1,730
Packing utilities								
Automatic field box filler	15	360	1	1	1	1	1	1,320
Sizing[b]								
Sizer with 5 sizes	100	100	1	-	-	-	-	4,679
Sizer with 7 sizes	100	200	-	1	-	-	-	8,748
Sizer with 7 sizes	100	300	-	-	-	2	-	10,505
Sizer with 7 sizes	100	400	-	-	1	-	2	11,954
Packing trays								
16" - 16" x 45' return flow belt	100	200	b	b	2	b	4	2,500
Packing stands	75	-	4	8	16	23	31	11
Bagging								
Semi-automatic bagger	50	50	1	2	4	6	8	1,244
15' filled bag conveyor	50	-	1	-	-	-	-	600
20' filled bag conveyor	50	-	-	1	1	2	2	700
Semi-automatic bag closer	50	-	-	-	1	2	2	1,790
Accumulating table	50	-	1	1	1	2	2	575

Table 2 (continued)

A	B	C	D					E
Operation and equipment item	Percent of packout handled	Hourly capacity (40# boxes)	Hourly packout (tray packs & bags) 40# boxes					Price per unit
			100	200	400	600	800	
			(units)					(dollars)
Conveying packed boxes								
Conveyor belt 50'	100	-	-	2	2	4	4	1,018
Conveyor belt 73'	100	-	1	-	1	2	2	1,865
Skate conveyor 10'			2	2	3	4	6	30
Alternate 1C - hand truck		200	1	1	2	3	4	72
Alternate 2C - fork lift truck		800	-	.5	1	1	1.5	9,610
Pallets		-	-	50	100	130	150	7

[a]Assumes a packout of 70 percent with 25 percent culls and utilities and 5 percent under 2 1/4 inches. Of packed apples, up to 75 percent may be tray packed and up to 50 percent may be bagged.

[b]Packing belts included with sizer.

to estimate cost and then add to other costs in the table to estimate total cost.

The initial investment cost of equipment for packinghouses with hourly output (packout) capacities of 100, 200, 400, 600 and 800 boxes was derived from the data in Table 2 and is presented in Table 3. Table 3 also shows the difference in initial investments for building and equipment combined for each of the packinghouse sizes. The reader will note by scanning the equipment items and prices that larger capital outlays are needed for the larger size units in order to mechanize the operation. The remaining difference in investments is due to the difference in size of buildings. For example, the total equipment and building investment for the 200-box house is $103,871 and for the 400-box house it is $150,721, a difference of $46,850. This implies a favorable substitution of capital for labor in addition to a lowering of unit costs by increasing volume. The larger investment includes machines which displace labor at a lower cost/output ratio. It is worth noting at this point that output was increased 100 percent with an increase in capital outlay of approximately 50 percent. Both capital substitution and volume effects on unit costs are discussed later.

Operating Requirements

Operating inputs are those supplies and services required only when the packinghouse is operating. The typical inputs used in this study are presented in Tables 4 and 5 and are described as labor, utilities, supplies and services. Wage rates are not shown because of the wide range existing in the apple packing area. However, selected wage rates are used in examples in a later section.

Labor Requirements

The labor requirements for receiving, grading and packing apples utilizing field boxes (Alternate 1A) and bulk boxes (Alternate 2A) for packinghouses with hourly packout capacities of 100, 200, 400, 600 and 800 boxes are presented in Table 4. The industry generally agrees that Alternate 1A will be technically infeasible for output capacities in excess of 200 boxes per hour for future operations. Also, all size operations may need to convert to palletizing and fork lift methods to

Table 3. Initial investment cost of packinghouses with selected rates of output

Item	Hourly packout (tray packs and bags)				
	100	200	400	600	800
	(dollars)				
Equipment					
Receiving and dumping	997[a]	11,364[b]	18,761[b]	25,690[b]	31,756[b]
Washing	2,328	2,731	4,139	6,511	8,278
Waxing and drying	9,377	12,933	15,647	25,867	31,294
Sorting	1,704	2,326	3,250	5,592	6,499
Conveying culls and utilities	2,040	2,112	2,688	4,800	5,376
Packing culls and juice	1,584[c]	2,076[d]	2,076[d]	2,076[d]	2,076[d]
Packing utilities	1,584	1,584	1,584	1,584	1,584
Sizing	5,615	10,497	14,345	25,212	28,690
Packing tray	53	106	6,211	304	12,409
Bagging	2,903	4,516	9,649	16,313	19,298
Conveying packed boxes	2,396[e]	8,701[f]	17,161[f]	22,130[f]	28,136[f]
Total equipment cost	30,581	58,946	95,511	136,079	175,396
Total building cost	38,180	44,925	55,210	82,560	93,809
Total initial investment cost[g]	68,761	103,871	150,721	218,639	269,205

Table 3 (continued)

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[a]Alternate 1A: Field boxes and hand trucks.

[b]Alternate 2A-1: Bulk boxes, fork lift trucks and float dumper.

[c]Alternate 1B: Automatic field box filler.

[d]Alternate 2B: Automatic bulk box filler.

[e]Alternate 1C: Hand truck.

[f]Alternate 2C: Fork lift truck.

[g]Excluding cost of land. Freight and installation were included in the equipment cost figures at 20 percent.

conform with handling and transportation systems of wholesale and retail distributors. For these reasons, this study does not evaluate the capital-labor substitution rate for converting from Alternate 1A to 2A. However, one should note a possible cost saving in that for the 200-box-per-hour house, three fewer workers are employed for the receiving and dumping and transporting for shipment operations with Alternate 2A than for 1A. The difference in labor cost[4] of $4.40/hour saved by displacing this labor over a reasonable time span probably would offset the added cost of fork lift machines. Certainly studies of similar operations support this premise.

Utilities, Supplies and Services

The utilities, supplies and services required for receiving, grading and packing apples in packinghouses with hourly packout capacities of 100, 200, 400, 600 and 800 boxes and unit prices are presented in Table 5. The hourly cost of any item for any selected hourly packout may be calculated by multiplying units per hour times price per unit. Of course, total hourly cost for the selected operation is determined by summing the computed costs of all the items listed in the table. The requirements in Table 5 assume the plant to be operating at 100 percent capacity. For plants operating at less than 100 percent of capacity, requirements for certain supplies (containers, tray and paper or poly bags, and staples) may be reduced by the same percentage that output is reduced since the quantity of these requirements is directly related to the number of boxes packed.

Hourly Operating Costs

The hourly costs of operating the packinghouses in this study represent the variable costs which must be paid if the plant is operated any number of hours during one or more seasons. They do not include fixed or investment costs as mentioned earlier. Table 6 presents itemized hourly operating costs for each of the packout capacities. These costs were determined by using the data in Tables 4 and 5. In order to determine hourly operating costs, certain assumptions must be made. These include

[4]Hourly wage rates used as found in footnote of Table 6.

Table 4. Labor requirements for alternative handling methods in relation to selected rates of output to receive, grade and pack apples[a]

Operation and job description	Percent of packout handled	Hourly production standard (40# boxes)	Maximum hourly packout (tray pack & bags) 40# boxes				
			100	200	400	600	800
			(number of workers)				
Receiving & dumping							
Alternate 1A - field boxes							
Hand truck operator	142	145	1	2	-	-	-
Manual dumper	142	183	1	2	-	-	-
Alternate 2A - bulk boxes							
Fork lift operator	142	1,000	-	.5	1	1	1.5
Dump operator	142	1,200	-	1	1	1	1
Sorting							
Manual sorter	135	63	3	5	7	9	11
Packing							
Tray packer	65	17	4	8	16	23	31
Bag filler-closer	35	18	2	4	-	-	-
Bag filler	35	25	-	-	6	9	12
Bag closer	35	310	-	-	1	1	1
Box filler (bags)	35	107	1	1	2	2	3
Lidding & stamping							
Box lidder (telescope lid)	100	263	(.4)	(.8)	(1.5)	(2.3)	(3)
Box stamper	100	612	(.2)	(.4)	(.7)	(1)	(1.3)
Crew--lid & stamp			1	2	3	4	5

Table 4 (continued)

Operation and job description	Percent of packout handled	Hourly production standard (40# boxes)	Maximum hourly packout (tray pack & bags) 40# boxes				
			100	200	400	600	800
			(number of workers)				
Container make-up							
Manual carton maker	100	114	1	2	4	6	7
Transporting for shipment							
Alternate 1C							
Hand truck operator	142	200	1	2	4	5	6
Alternate 2C							
Fork lift operator	142	1,000	-	.5	1	1	1.5
Hand truck operator	-	-	-	1	1	2	2
Tallying							
Checker	-	-	1	1	1	1	1
Miscellaneous laborer[b]	-	-	1	2	5	7	11

[a]Assumes a packout of 45 percent tray pack, 25 percent bags, 25 percent culls and utilities, and 5 percent under 2 1/4".

[b]Responsible for clean-up, maintenance, minor repairs, and assistance wherever needed.

Table 5. Utilities, supplies, and services in relation to selected rates of output to receive, grade, and pack apples in 40-pound cartons

Item and description	Unit	Hourly packout (tray pack & bags)					Price per unit[a]
		100	200	400	600	800	
		(units per hour)					(dollars)
Fiberboard containers[b]	Each	101	202	404	606	808	.38
Tray and paper or poly bags	Lot	100	200	400	600	800	.20
Staples	Lot	100	200	400	600	800	.02
Wax	Gal.	.2	.4	.9	1.4	1.8	2.75
Office supplies[c]	Lot	.5	1	2	3	4	.25
Telephone[c]	Dollars	2.0	2.5	3.3	4.5	5.0	--
Utilities							
Electricity[c]	KWH	25	30	40	55	60	1.5
Water	M Gal.	.2	.3	.4	.8	1.0	--

[a]Delivered basis.

[b]Assumes 1 percent of cartons damaged.

[c]Source: Planning Data for Marketing Selected Fruits and Vegetables in the South, Part III, Fresh Vegetable Packing Handbook, Southern Cooperative Series Bulletin No. 152, May 1970.

Table 6. Hourly operating costs for packinghouses with selected rates of output[a]

Item	Hourly packout capacity				
	100	200	400	600	800
	Hourly cost[b] (dollars)				
Labor					
Receiving and dumping	3.20[c]	2.60[d]	3.60[d]	3.60[d]	4.60[d]
Sorting	5.25	8.75	12.25	15.75	19.25
Packing	11.82	22.04	42.48	61.32	80.16
Lidding and stamping	1.60	3.20	4.80	6.40	8.00
Container make-up	1.60[e]	3.20[f]	6.40[f]	9.60[f]	11.20[f]
Transporting for shipment	1.60[e]	2.60[f]	3.60[f]	5.20[f]	6.20[f]
Tallying	1.60	1.60	1.60	1.60	1.60
Miscellaneous	1.60	3.20	8.00	11.20	17.60
Social security[g]	1.47	2.45	4.30	5.96	7.73
Total labor	29.74	49.64	87.03	120.63	156.34
Utilities and supplies					
Fiberboard containers	34.58	69.16	138.32	207.10	276.34
Tray and paper or poly bags	18.00	36.00	72.00	108.00	144.00
Staples	1.80	3.60	7.20	10.80	14.40
Wax	.55	1.10	2.47	3.85	4.95
Office supplies	.13	.25	.50	.75	1.00
Telephone	2.00	2.50	3.30	4.50	5.00
Electricity	.38	.45	.60	.83	.90
Water[h]	.05	.07	.10	.19	.24
Waste disposal[h]	.03	.04	.05	.10	.12
Miscellaneous	.50	1.00	1.50	2.00	2.50
Total utilities and supplies	58.02	114.17	226.04	338.12	449.45
Brokerage fee[i]	19.80	39.60	79.20	118.80	158.40
Other operating costs[j]	5.38	10.17	19.61	28.88	38.21
Total hourly operating costs	112.94	213.58	411.88	606.43	802.40
Costs per box					
Labor	.33	.28	.24	.22	.22
Utilities and supplies	.64	.63	.63	.63	.62
Brokerage fee	.22	.22	.22	.22	.22
Other	.06	.06	.05	.05	.05
Total operating costs per box	1.25	1.19	1.14	1.12	1.11

Table 6 (continued)

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[a]Plants are assumed operating at 90 percent of capacity and assumes a packout of 45 percent tray pack, 25 percent bags, 25 percent culls and utilities and 5 percent under 2 1/4".

[b]Based on hourly wages of $1.60 except at $2.00 for fork lift operators, $1.75 for graders and $ .12 per box for tray packers.

[c]Alternate 1A - field boxes and hand trucks.

[d]Alternate 2A - bulk boxes, fork lift trucks and float dumper.

[e]Alternate 1C - hand truck.

[f]Alternate 2C - fork lift truck.

[g]Based on rate in effect in 1971--5.2 percent of payroll.

[h]Based on a water cost of $ .24 per 1,000 gallons and a cost of waste disposal of 1/2 the water cost.

[i]Calculated at 5 percent of gross sales at an average price of $4.40 per box ($ .22 per box sold).

[j]Includes interest on operating capital, office employees, and other miscellaneous expenses. It is calculated at 5 percent of the total cost of labor, utilities and supplies, and brokerage. Actual costs reported by packing plants indicate that this method will yield a very close approximation of these costs.

the wage rate to be paid and the plant efficiency expected. These assumptions are noted in the footnotes to Table 6. The reader is reminded that changing these assumptions will result in changes in the hourly cost data.

By dividing each of the major items in the operating cost table by the number of boxes packed per hour, the cost per box for each is obtained. It should be noted that most operating cost items are fairly constant across all sizes. The reduction in labor cost is due to the more efficient use of labor and increased mechanization in the larger size packinghouses. The operating cost per box is useful in helping the owner of an existing packinghouse decide if he should operate it for any single season and is the only cost information necessary to make this decision. An owner should operate his facility as long as the operating cost per box is less than it will cost him to have his fruit packed by another packer. This will be true even if total cost per box (annual cost plus operating cost) may be greater than what he would have to pay to have his fruit packed by someone else. The annual cost will be incurred regardless of whether he operates his plant; therefore, these costs are not considered. The same principle is true if he is packing for other growers. He should continue to operate as long as the price he receives for packing is greater than his operating cost per box.

Total Costs

In the long run, building and equipment investment costs and costs associated with these investments--interest, taxes, insurance, etc.--must be added to operating costs to determine the total cost of packing and selling apples. Table 7 shows the investment costs, both total and as converted to an annual basis, the operating costs and total costs of operating 200- and 400-box-per-hour plants for 300- and 400-hour seasons.

The hourly costs in Table 6 were used to determine the operating costs in Table 7. The annual cost items were determined as explained in the footnotes to Table 7. This same methodology may be used to determine total costs of operating any of the packinghouses for any desired season length.

Economies of Scale and Volume Effects

The bottom section of Table 7 shows the annual, operating, and total costs per packed box for the two plant sizes and season lengths. Scale effects are observed by comparing annual costs per box or total costs per box for the two plant sizes for a single length of season. Effects of increasing volume may be observed by comparing these costs for a single plant size for two lengths of season. In the first case, the annual cost per box decreases $ .09 (.35 - .26 = .09) when plant size is increased from 200 to 400 boxes per hour operating for 300 hours. In the second case, annual cost per box decreases $ .06 (.26 - .20 = .06) when length of season is increased form 300 to 400 hours for the 400-box-per-hour plant. In the case where both length of season and size of plant are increased, the decrease in cost per box is $ .15 (.35 - .20 = .15).

Savings of this magnitude, resulting from increasing investment and output capacity, must be considered by North Carolina operators in the future if they are to maintain or increase existing net returns from their apple packing enterprises; otherwise, competing areas may obtain a competitive advantage by implementing similar cost savings. Of course, improved operating efficiency will provide another major means of decreasing total cost per box packed.

Table 7. Total costs of receiving, grading, packing, and selling apples for two plant sizes and two season lengths

Item	Plant size[a]	
	200 boxes per hour	400 boxes per hour
	(dollars)	
Investment costs		
Building costs	44,925	55,210
Equipment costs	58,946	95,511
Total	103,871	150,721

	300-hour season	400-hour season	300-hour season	400-hour season
Annual and operating costs				
Annual costs				
Depreciation[b]	8,141	8,141	12,287	12,287
Interest on investment[c]	4,155	4,155	6,019	6,019
Insurance[d]	1,039	1,039	1,505	1,505
Repairs and maintenance[e]	1,558	1,558	2,257	2,257
Taxes[d]	1,039	1,039	1,505	1,505
Manager's salary[f]	3,156	4,208	3,156	4,208
Foreman[g]			1,262	1,683
Total annual costs	19,088	20,140	27,991	29,464
Operating costs				
Labor	14,892	19,856	26,109	34,812
Utilities and supplies	34,251	45,668	67,812	90,416
Brokerage fee	11,880	15,840	23,760	31,680
Other operating costs[h]	3,051	4,068	5,883	7,844
Total operating costs	64,074	85,432	123,564	164,752
Total annual and operating costs	83,162	105,572	151,555	194,216
Costs per packed box				
Annual cost per box	.35	.28	.26	.20
Operating cost per box	1.19	1.19	1.14	1.14
Total cost per box	1.54	1.47	1.40	1.34

Table 7 (continued)

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[a]Plants are assumed to be operating at 90 percent of the stated capacity.

[b]Depreciation was calculated using the straight-line method assuming a zero salvage value on the basis of 20 years for building and 10 years for equipment.

[c]Interest at 8 percent was calculated on one-half the total investment costs.

[d]Calculated at 1 percent of total investment.

[e]Calculated at 1.5 percent of total investment.

[f]Manager's salary was calculated at $10 per hour of operation plus 5.2 percent for FICA tax.

[g]Foreman's salary was calculated at $4 per hour plus 5.2 percent for FICA tax.

[h]Includes interest on operating capital, office employees, and miscellaneous expenses calculated at 5 percent of the total of labor, utilities and supplies, and brokerage fee.