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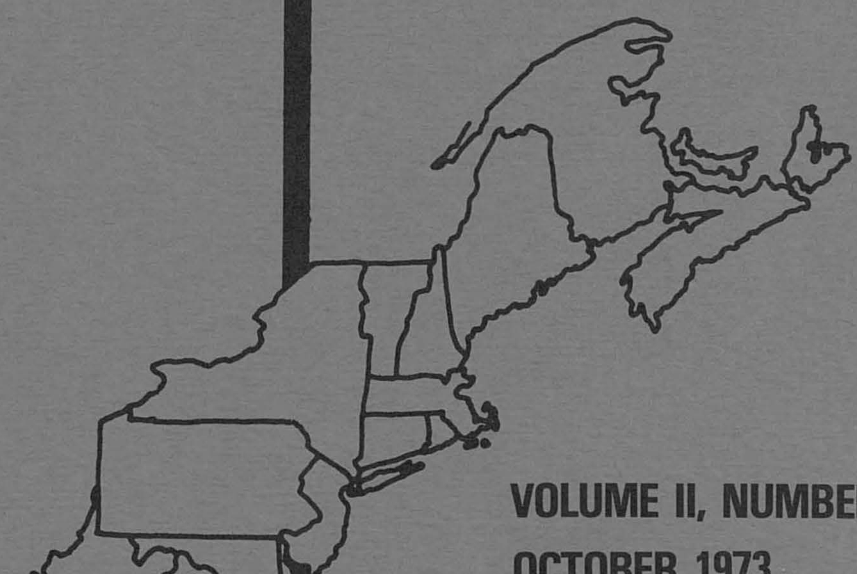

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ADJUSTMENTS IN THE OPTIMUM NUMBER, SIZE AND LOCATION OF TABLESTOCK POTATO PACKING PLANTS IN MAINE

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INTRODUCTION

The results of a study to determine the optimum number, size and location of potato packing plants in Maine were recently published.[1/] These results indicated that economic efficiency of the industry as a whole could be improved with a movement toward fewer and larger plants since aggregate costs of the three marketing functions—assembly, packing, and distribution to consumption centers—could be reduced. In addition to the economic efficiencies involved, the large plant is better able to respond to orders from buyers desiring a uniform and high quality pack in large volume. A small grower-packer, handling only his own potatoes, may not have the volume of potatoes necessary to offer a particular type of pack with any continuity.

A movement toward an industry structure of fewer and larger plants could therefore lead to more uniform quality in the end product and to more bargaining power on the part of the Maine fresh potato industry when dealing with buyers in the major markets. This could strengthen the competitive position of the Maine industry.

The final solution, as published in Bulletin 697, consisted of 9 plants of various sizes ranging from a capacity of 272,678 to 2,488,320 hundredweight of packed product per season (Table 1). The total industry capacity was 10,374,372 hundredweight which was just sufficient to pack the total production (1969 level of tablestock shipments). The assembly and distribution patterns are shown in Tables 2 and 3.

[1/]This paper is based upon research conducted at the University of Maine, Orono. Appreciation is extended to Winston W. Grant, former graduate assistant and to Associate Professors Edward F. Johnston and Edward S. Micka for their assistance. However, the author accepts responsibility for content.

Table 1

Optimum Locations and Capacities
of Fresh Potato Packing Plants

Plant Number	Plant Location	Plant Capacity
		(cwt./season)
2	St. Agatha	829,440
4	Caribou	2,488,320
5	Fort Fairfield	829,440
6	Washburn	442,714
7	Presque Isle	2,488,320
8	Monticello	1,658,880
10	Hodgdon	682,290
11	Crystal	682,290
14	Exeter	272,678
	TOTAL	10,374,372

Note: Plant capacity for Monticello includes two large plants, and capacities for Caribou and Presque Isle each include three plants.

These tables may be interpreted as follows. Table 2 indicates the assembly pattern and gives packing plant locations across the top and production origins down the left hand side. Numbers in the body of the table are the hundredweight of bin-run potatoes (packed equivalents) transferred from production origins to various plant locations. For example, Table 2 indicates that 793,222 hundredweight were transferred from area eight, Monticello, to plant eight, located in Monticello, and 389,004 hundredweight were transferred from area eight to plant seven, located in Presque Isle. Table 3 presents the distribution pattern and shows plant locations across the top and consumption centers down the left-hand side. Numbers in the body of the tables are the quantities of packed potatoes shipped from plants to consumption areas. For example, Table 3 indicates that 724,007 hundredweight were shipped from plant eight, located in Monticello to consumption center two, Portland, and 934,873 hundredweight from plant 8 to New York City.

Aggregate marketing costs for the final 9-plant solution are presented by function in Table 4.

Table 2

Assembly Pattern - Origins, Plant Locations and Volumes for the Least-Cost Solution

Production Origin	Packing Plant Location: (2) St. Agatha	(4) Caribou	(5) Fort Fairfield	(6) Washburn	(7) Presque Isle	(8) Monticello	(10) Hodgdon	(11) Crystal	(12) Exeter
	cwt.								
1 Fort Kent	507,236	823						81,788	
2 St. Agatha	322,204								
3 Connor		1,063,007							
4 Caribou		921,647	12,397						
5 Fort Fairfield			817,043						
6 Washburn		502,843		442,714	295,441				
7 Presque Isle					1,803,875				
8 Monticello					389,004	793,222			
9 Littleton						865,658	249,871		
10 Hodgdon							432,419		
11 Crystal								541,549	
12 Lee									55,462
13 Alexander									23,802
14 Exeter									137,488

Table 3

Distribution Pattern - Plant Locations, Destinations, Volumes
for the Least-Cost Solution

Consumption Center	Packing Plant Location								
	(2) St. Agatha	(4) Caribou	(5) Fort Fairfield	(6) Washburn	(7) Presque Isle	(8) Monticello	(10) Hodgdon	(11) Crystal	(14) Exeter
	cwt.								
1 Searsport, Me.	159,682								
2 Portland, Me.						724,007			
3 Albany, N. Y.			162,580						
4 Buffalo, N. Y.		14,025							
5 New York, N. Y.					293,793	934,873	682,290	285,142	216,752
6 Boston, Mass.	311,488	358,270	12,397	442,714	899,681				
7 Philadelphia, Pa.		733,370							
8 Pittsburgh, Pa.					458,480				
9 Baltimore, Md.					460,405				
10 Providence, R. I.			172,920						
11 Washington, D. C.			233,604		62,681				
12 Cincinnati, Ohio								87,780	
13 Cleveland, Ohio					313,280				
14 Atlanta, Ga.	119,405								
15 Columbia, S. C.	54,340								
16 Louisville, Ky.								95,535	
17 Nashville, Tenn.			11,660						
18 Miami, Fla.	184,525								
19 Detroit, Mich.								154,880	
20 Indianapolis, Ind.			158,070						
21 All Other Areas		1,382,655	78,209						

Table 4

Aggregate Marketing Costs by Function

Component	Total Cost	Average Cost	Percent of Aggregate Marketing Cost
	(million)	(cwt.)	
Assembling	$ 1.3	$0.1275	7.6
Packing	5.6	0.5472	32.4
Distribution	10.4	1.0129	60.0
TOTAL	$17.3	$1.6876	100.0

The distribution function was by far the largest component of the aggregate marketing cost, totaling $10.4 million or 60 percent of the aggregate marketing cost. The next largest contributor was the cost of packing potatoes which represented 32.4 percent or $5.6 million of the marketing bill. Assembly costs totaled $1.3 million, but represented only 7.6 percent of the aggregate costs considered in the study. These costs were calculated for assembly, packing, and distribution of the entire Maine tablestock potato crop. As such, they are only representative of actual costs in a particular area and show the relationships among the costs of performing the major marketing functions.

The study, as previously reported, concluded that 9 packing plants of specific size and location would be the optimum economic solution. The sensitivity of the final solution to certain changes was beyond the scope of that report, and it was felt that certain aspects were worthy of further investigation. Accordingly, the costs and flows of product of the following specific situations were tested and compared to the original 9-plant, least-cost, solution:

1. The exclusive use of plants of the smallest size. (Four plant sizes were assumed in the original analysis).

2. The 9-plant solution with changes in assembly costs.

3. A situation in which the market for all Maine potatoes was Boston or New York City or both.

4. A situation in which two additional packing plants were located in Boston and New York City.

RESULTS

Situation 1: All Small Plants

The Maine fresh potato packing industry consists of many very small plants and a few large plants. A situation consisting of several of the smallest plants considered in the analysis, located at 12 of the potential plant sites used in the earlier study, was tested in order to gain some insight into the relative costs and flows of product compared to the least-cost solution.

The smallest plant for which the cost data was computed was 263 hundredweight of raw product per hour (a rate of about 2½ truckloads per day) and an annual output capacity of 272,678 hundredweight. It would take 38 plants of this size to pack the total production at the level studied. The solution, shown in Tables 5 and 6, resulted in a total aggregate marketing cost of $18 million, which was an increase of 4.0 percent over the 9-plant solution of $17.3 million. Both the direction and volume of the flow of product to and from the plant sites changed considerably from the previous optimum.

The changes in flow occurred because there were no packing economies to be gained from shipping to a larger plant in another area. Production for a given area remained within the area and the flows of product were thus modified from the 9-plant solution when product was shipped to a few large plants.

Turning the interpretation around, what economies were there in reducing the number of plants from 38 to 9? The effect on aggregate marketing costs are shown in Table 7. Aggregate marketing cost decreased by $0.8 million or 4.5 percent. Industry assembly costs increased as expected. Potatoes must be hauled a greater distance to the packing plant. Industry packing costs decreased by over 3/4 million dollars or 12 percent. This is where the major cost reduction potential rests. Table 7 also shows small economies from more efficient distribution to the markets from the larger plants. If costs were recalculated to reflect those which would exist using packing plants of the very small size often found in Maine, the savings as plant sizes were increased and numbers of plants reduced would be substantially greater. It should also be pointed out that cost economies are not the only advantage to larger plants. The larger plant should be better able to pack the type of consistent, high quality pack large buyers desire, thus perhaps increasing returns.

Situation 2: Changes in Assembly Costs

Two tests were run with changes in the cost of assembling the raw product; one with a 10 percent decrease and the other with a 10 percent increase in the transfer cost rates. In both cases the 9-plant solution was used as a base.

Table 5

Assembly Pattern - Origins, Plant Locations and Volumes for All Small Plants

Production Origin	Packing Plant Location											
	(1) Fort Kent	(2) St. Agatha	(3) Connor	(4) Caribou	(5) Fort Fairfield	(6) Washburn	(7) Presque Isle	(8) Monticello	(9) Littleton	(10) Hodgdon	(11) Crystal	(14) Exeter
	cwt.											
1 Fort Kent	545,356										11,572	32,919
2 St. Agatha		272,678									49,526	
3 Connor			1,063,007									
4 Caribou			27,705	906,339								
5 Fort Fairfield				184,373	632,670							
6 Washburn						1,240,998						
7 Presque Isle					185,364	122,392	1,363,390				132,729	
8 Monticello								1,090,712	91,514			
9 Littleton									999,198	112,937	3,394	
10 Hodgdon										432,419		
11 Crystal											541,549	
12 Lee											55,462	
13 Alexander											23,802	
14 Exeter												137,488

Table 6

Distribution Pattern - Plant Locations, Destinations and Volumes for All Small Plants

	Consumption Center	Packing Plant Location											
		(1) Fort Kent	(2) St. Agatha	(3) Connor	(4) Caribou	(5) Fort Fairfield	(6) Washburn	(7) Presque Isle	(8) Monticello	(9) Littleton	(10) Hodgdon	(11) Crystal	(14) Exeter
		-cwt.-											
1	Searsport, Me.	159,682											
2	Portland, Me.								724,007				
3	Albany, N. Y.						162,580						
4	Buffalo, N. Y.					14,025							
5	New York, N. Y.						109,264	741,279	366,705		449,821	575,374	170,407
6	Boston, Mass.		180,181		358,270	391	210,023	184,373		1,090,712			
7	Philadelphia, Pa.				732,442	928							
8	Pittsburgh, Pa.			458,480									
9	Baltimore, Md.			460,405									
10	Providence, R. I.	27,404	92,497				53,019						
11	Washington, D. C.			171,827				124,458					
12	Cincinnati, Ohio											87,780	
13	Cleveland, Ohio							313,280					
14	Atlanta, Ga.	119,405			25,378								
15	Columbia, S. C.	54,340											
16	Louisville, Ky.										95,535		
17	Nashville, Tenn.						11,660						
18	Miami, Fla.	184,525											
19	Detroit, Mich.											154,880	
20	Indianapolis, Ind.						158,070						
21	All Other Areas					802,090	658,774						

Table 7

Aggregate Marketing Costs, 9-Plant and 38-Plant Solution

Item	38-Plant Solution	9-Plant Solution	Changes Dollars	Changes Percent
	(mil. dol.)	(mil. dol.)	(million)	
Total Industry Assembly Costs	1.2	1.3	+.1	+ 8
Total Industry Packing Costs	6.4	5.6	-.8	-12
Total Industry Distribution Costs	10.5	10.4	-.1	- 1

When assembly costs were decreased 10 percent, the analysis yielded no change in the pattern of flow from production areas to packing plants or from the plants to consumption areas. Total aggregate costs decreased by $109,733 or 0.6 percent from the original 9-plant optimum solution.

When assembly costs were increased 10 percent, there were slight adjustments in the pattern of distribution of packed potatoes from plants 5, 6 and 7 only (Table 2). The total aggregate marketing cost increased by $159,032 or 0.9 percent.

The comparisons made under these situations would indicate that assembly cost changes would have little effect upon the optimum number, size and location of potato packing plants. It may be that the important transportation costs are those involved in hauling the potatoes from the field to the storage shed. Costs of hauling from field to farm storage are independent of the plant location question and an investigation of these costs was beyond the scope of the present study.

<u>Situation 3: Limiting the Markets to Boston and New York</u>

Since transportation cost for assembly did not greatly effect the optimum number, size, and location of plants, it seemed reasonable to investigate the possible savings if the market for Maine potatoes was more concentrated and the packaged product moved over shorter distances. At the present time, Maine ships packed potatoes to several markets in Eastern United States. (See Table 3).

It should not be expected that the total product could be shipped to Boston and New York only, but it would seem that the enlargement of Maine's share of these markets would enable the shipper to effect some transportation cost savings by cutting down the distance over which the product is shipped. Further study of the feasibility of expanding the size of Boston and New York markets would be necessary.

This analytical model makes use of fixed quantities of demand and therefore should be considered of limited usefulness in looking at possibilities for expanding quantities shipped to a given market area. No provision is made for the effect on prices of the increased quantity supplied. Nevertheless, the 9-plant solution was run first with all the packed product assumed shipped to Boston, then all to New York City, then with half the total to each of the two markets. The results showed no change in the pattern of assembly of product from production area to packing plant, but some savings did occur in aggregate costs. With all potatoes shipped to Boston, a savings of 20 percent accrued ($3,516,605). When all potatoes were shipped to New York City, the savings was just under 10 percent ($1,672,794), and when the product was divided equally between the two markets, a 15 percent saving occurred ($2,668,488). This might give some indication of the upper bound.

Situation 4: Packing Plants Located in Boston and New York City

When potential plant sites were chosen for the original study, it was assumed that bin-run potatoes would not be hauled further than 60 miles for packing. The effect of relaxing that assumption was tested in the hypothetical situation.

The maximum effect of this alternative would be to allow packing of bin-run potatoes in all the consumption areas. The effect was tested, however, by adding two large packing plants to the 9-plant solution, one in Boston and one in New York.

Transportation costs from Maine producing areas to these two plants were determined by adjusting the relevant packed potato distribution costs from the original study to account for shipment of bin-run potatoes. The analytical model was used twice; once with no change in packing costs from the same size plant in Maine and a second time with packing costs increased 20 percent. It might be expected that building costs, utilities and labor would be somewhat higher and that there might also be increased waste disposal problems with plants located in large Metropolitan areas. In the first case, aggregate costs were reduced 1.2 percent. When packing costs for the two plants were increased 20 percent, aggregate marketing costs were reduced only 3/4 of one percent from the 9-plant optimum solution. Furthermore, in the second case the two plants only handled 4.6 percent of the total production.

The limited use of this model indicated a slight decrease in aggregate costs when plants were located in two consumption areas. It seems that it might be easier to place a high quality pack in the hands of the consumer if the potatoes were packed and graded in the consumption area. This alternative might be worthy of further exploration and testing.

CONCLUSIONS

These results support the conclusion that fewer and larger tablestock potato packing plants would increase the economic efficiency of the Maine potato industry. A shift from the exclusive use of 38 plants of the smallest size plant tested to the original 9-plant optimum reduced aggregate marketing costs. With fewer and larger plants, assembly costs become a larger proportion of the total. However, alternatives were tested with increased assembly costs and the solution indicated that the pattern of assembly and distribution would not be changed markedly. Total costs, with increased assembly costs also changed little from the basic 9-plant solution.

It appears that there would be economic advantages to a more concentrated market for Maine potatoes. These would accrue primarily from the reduction in transportation costs.

The study also supports the hypothesis that the economies to be gained because of large size may not be as great as the gains obtained from being in a better position to market the potatoes more effectively because of greater consistency and volume of packed product. Therefore, even with limited gains in economic efficiency, an industry structure of fewer and larger packing plants could strengthen Maine's competitive position in the market.

References

(1) King, F. Richard and Grant, Winston W. "1970 Survey of Maine Potato Growers," Maine Agricultural Experiment Station, University of Maine at Orono, ARE 187, June 1971.

(2) King, F. Richard, Winston W. Grant and Edward S. Micka, "Optimum Number, Size and Location of Tablestock Potato Packing Plants in Maine," LSA Experiment Station, University of Maine at Orono, Bulletin 697, Sept. 1972.