IMPENDING TECHNOLOGICAL CHANGE IN CALIFORNIA ICEBERG LETTUCE

By

David Schaffner and Jim Ahern
Associate Professor and Assistant Professor
Agricultural Management Department
California Polytechnic State University
San Luis Obispo, California 93407

The authors present a "model" reflecting a more capital-intensive labor-saving handling/harvesting system.

Introduction

California holds a dominant share of the U.S. market for head lettuce, shipping 400 carloads daily throughout the world. California's $0.5 billion sales gives it a 75% share of the iceberg lettuce market, built on climatic advantage, superior cultural practices, plentiful labor, and other production economies. However, transportation and labor inputs currently threaten the future of the industry in California. While all industry is faced with increased energy costs few products represent such a low unit value for distant shipments. On the labor side, negotiation with the United Farm Workers throughout the seventies and into the eighties has not provided stability in labor supply or cost. Union involvement in what have been traditionally management prerogatives (i.e., right to hire and fire and voluntary overtime provisions) plus the harvest period strikes have been extremely troublesome for a commodity as perishable as lettuce.

Both the labor problems and the continually spiralling energy costs - shipping costs in 1979 were approximately four times the f.o.b. shipping point price - threaten to erode the advantages held by California producers. The obvious answer, to maintain the comparative advantage held in the past, is to develop new technology for the handling/harvesting tasks. A system that allows capital to be substituted for labor would reduce the labor-intensive nature of growers' packing needs.

Study Objectives

Industry viability may depend upon achieving labor economies as a route to reducing production costs, a step which historically appears necessary for the stability of the California industry. It is hypothesized that a "model" system can be devised that will achieve substantial savings to grower/shippers. Given that, the objectives are:

1) To present a more capital-intensive, labor-saving handling/harvesting system;

2) To evaluate the economic viability of the proposed system vis-a-vis the existing labor-intensive system.

Assumptions

The model harvesting/handling system assumes normal field work methods for cost comparisons, representative

output for full work days, and current work rules and environment. Fuel costs are based on each piece of equipment used and are estimated to increase at a rate of ten percent annually. Wage prices are set at a fifteen percent annual rate of increase. A 48 week season is used, allowing four weeks of machinery downtime and 1960 hours of operating time. Lastly, it is assumed that source wrapped lettuce (i.e., cello wrapped) will continue to increase in market share, and that by the mid-1980's will account for 70 percent of all lettuce sales.

Methodology

A survey of 28 produce buyers and merchandizers, a non-probability sample from an original sample of 80 mailed, was used to set the basis for existing marketing behavior and product handling techniques. Due to the non-random nature of the sampling the data was not used for statistical tests, but rather as an indicator of current practices. The sample included seven of the top ten* retail chains, who expected source-wrapped lettuce to expand its market share in the eighties, due to convenience, labor savings, and quality.

Grower-shipper viewpoints were gathered in a series of 24 personal interviews, augmented by a review of literature on mechanical harvesting, bin shipping, and efficiency of harvest operations.

A capital budgeting approach, employing present value analysis, was used to examine the model system. Although accepted by agribusiness few published industry studies utilize capital budgeting. Therefore this study may provide a useful framework for similar future studies.

The Systems

The Existing System - Hand-Harvested Lettuce Handling

The present lettuce handling regime contains a large number of separate handlings from production through retail (see Figure 1) (Cargill and Garrett). Harvesting, packaging, and transportation costs represent $.304 of a $.69 per head normal retail price.

The system for ground pack crews keys on the "trio"- two cutters and one packer. The cutters distribute cartons, then proceed through the row, selecting firm, mature heads, cutting them, and removing their wrapper leaves. Each cutter works two beds from a single row. The packer follows in the middle furrow of the four beds packing lettuce left on the beds into paperboard cartons, 24 or 30 per carton, depending on head size. The cartons are closed, stapled, and left in a windrow for loading.

Film wrapping uses a large mobile platform with collapsible side wings that span twelve beds. Cutters place heads on the wrap machine, essentially a platform for cello wrappers who wrap, seal, and place heads on a conveyor. The heads are then packed into cartons and returned to the ground or carried and palletized for transfer to truck. This system requires a slightly smaller crew of 33 with fewer cutters and packers and more wrappers (see Table 1).

After field-loading onto pallets, the lettuce is transported to the vacuum cooler where it is quick cooled. The lettuce is then loaded directly into refrigerated rail cars or trucks for shipment to consumer markets. At destination the lettuce is handled at a wholesale distribution center for reshipment (24 to 48 hours) to the retail

*Hereafter the term "top ten" refers to conclusions from interviews with these seven retail grocery chains.

Figure 1. Job Analysis of Present Hand-Harvested Source Wrap System (11 hand labor processes) and the Model Harvesting/Handling System (4 hand labor processes).

# 1.	Select, cut, trim, place heads on bed
# 2.	Head pickup and place on machine
# 3.	Wrap heads
o 4.	Convey to packer
# 5.	Pack into carton
# 6.	Staple carton
o 7.	Groupdrop cartons into windrows
# 8.	Load cartons on palletized truck
* 9.	Transport to cooler
o10.	Unload by forklift
o11.	Load pallets onto cooler conveyor
o12.	Vacuum cool
o13.	Pallets to cool room or direct to van
o14.	Slipsheet unitized pallet load to truck
*15.	Transport to destination market
o16.	Unload truck with slipsheet
o17.	Place on distribution center pallet
o18.	Move to refrigerated storage
@19.	Temporary storage at distribution center
#20.	Retail order assembly - hand transfer to pallet
o21.	Delivery pallet to assembly area
o22.	Load truck with forklift
*23.	Transport to retail store
#24.	Unload with pallet jack, to storage
#25.	Hand stack cartons in cooler
@26.	Store in cooler
#27.	Hand load store cart in cooler
#28.	Move to retail counter, arrange display

o 1.	Select, cut, and rough trim lettuce
o 2.	Elevate head into truck
* 3.	Transport to fieldside pack station
o 4.	Unload truck
# 5.	Finish trim, inspect for wrapping
o 6.	Wrap heads
o 7.	Fill mini-bins
# 8.	Lid bins
o 9.	Forklift bins onto pallet on truck
*10.	Transport to cooler
o11.	Unload pallets by forklift
o12.	Load pallets onto cooler conveyor
o13.	Vacuum cool
o14.	Pallets to cool room or direct to van
o15.	Slipsheet bins into van, load truck
*16.	Transport to destination market
o17.	Unload truck with slipsheet
o18.	Place on distribution center pallet
o19.	Move to refrigerated storage
@20.	Distribution center temporary storage
o21.	Retail order assembly - bin transfer by pallet
o22.	Load truck with forklift
*23.	Transport to retail store
#24.	Unload with pallet jack, to storage
@25.	Store in cooler
#26.	Move bin to retail counter by pallet jack, arrange display

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Key: o - Mechanical Process
- Hand Process
@ - Storage Process
* - Transportation

Table 1. Typical Iceberg Lettuce Crews for Ground Pack and Film Wrapped

Job Description	Ground Pack	Film Wrap
Select-Cut-Trim	18	14
Carton Assemblers	2	1
Wrappers	0	9
Packers	9	4
Wash Butt (Sprayer)	1	0
Closers	2	2
Loaders	4	3
Total	36	33

Source: Johnson and Zahara

outlets, where it normally moves out within 36 hours.

The Model System

The model system would seek to eliminate many hand labor processes throughout the system by use of four innovations: 1) selective mechanical harvesters, 2) portable fieldside packing stations equipped with automatic wrapping equipment, 3) grower-shipper entry into the precut market using the 15 percent source-wrapped reject product (not marketable as fresh), and 4) use of mini-bin packing at fieldside suitable for retail use. The system could save as much as 270,000 man-hours in handling 2,250,000 cartons of lettuce.

The survey of produce buyers leads to the conclusion that an increased use of wrapped lettuce was likely due to convenience, labor efficiency, and quality considerations. The needs of the model system were seen as:

- a reduced number of handlings
- an increased utilization of lettuce in the field
- maintenance of product quality levels
- melding well with existing transportation
- consideration of energy efficiency
- improvement of job safety and working conditions
- savings accruing to all marketing steps

The use of an x-ray selector harvester (Adrian), fieldside packing, and mini-bins* offers the ability to reduce the field-packing labor contingent from 247 to 109 persons. Additionally, handling savings would accrue at both the wholesale and retail levels. The system would allow more accurate selection, as x-rays identify the heads with proper size and density. Growers could then successfully utilize a second pass, increasing productivity per acre.

A major portion of the system's efficiency would come from the use of the

*Mini-bins provide a 40 by 120 cm disposable replacement for the standard paperboard cartons. A single mini-bin would contain 15 carton equivalents of lettuce.

portable fieldside packing station, which is designed to be relocated five to seven times annually among the growing districts (such as the Salinas Valley, Palo Verde and Imperial Valleys, and the San Joaquin Valley). Each location requires a fenced, paved two acre set-up space with utilities and laborer conveniences. The station can handle the output of three mechanical harvesters and is expected to operate 48 weeks per year, with four weeks downtime for maintenance and repairs.

An opportunity exists for the grower-shipper to utilize product previously left for "gleaners" by augmenting his head lettuce activities with a pre-cut operation. Such processed or shredded lettuce is marketed effectively to the institutional or food service sector. This market offers the advantages of more stable product price and entry into a branded product market. Pre-cut is usually marketed in 10 to 20 pound bags and provides overall cost savings to food service users. Currently, only 6 percent of the institutional lettuce market is held by pre-cut, but it seems possible that that share could increase to 60 percent.

The system's mini-bins, utilized from field to retail as replacements for standard cartons, would be compatible with all transportation and distribution systems (wholesale and retail). Sixty percent of the "top ten" retailers stated that they could handle and merchandise mini-bin shipments. Such shipments would reduce manual rehandling in the marketing phase by three of five current tasks (see Figure 1). The use of mini-bins would allow greater density in product shipment and reduce the number of units handled per week. Additionally, the bins would result in a 33 percent reduction in grower-shipper carton material costs.

Cost Comparison

The model system requires 56 percent less hand system labor in harvesting the equivalent of 1350 cartons per hour of wrapped and pre-cut lettuce. This reflects a savings of $0.89 per carton equivalent, or $.037 per head, which is expressed as an annual labor savings of 270,000 man-hours and expanded at a rate of 15 percent annually. The first year's use would result in a $2.4 million savings.* Container cost savings from mini-bin use begins at $0.23 per carton equivalent and expanded at the rate of eight percent annually.

The increased capital requirement places total capital required for the model system at $1.6 million. This includes three mechanical harvesters at $160,000 each, six packing station locations (land, asphalt, fencing, and facilities) at $101,000 each, and the balance for the portable packing station equipment and its six automated wrappers. The figures were obtained from equipment dealers and manufacturers.

The approximate cash flows are detailed in Table 2. Note that labor costs savings are by far the dominant factor and are based on not unreasonable assumptions regarding the growth of agricultural labor wages in five years. Labor savings beyond the grower-shipper are not included, but undoubtedly would be substantial. Table 3 illustrates the discounted net cash flows which indicate a breakeven project within one year of operation at an interest rate of 25 percent.

Management requirements for the

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*The savings is the product of 270,000 man-hours and an $8.77 hourly wage cost, subsequent savings increase by 15 percent annually.

Table 2. Summary of Cash Flows in Thousands of Dollars From Model Lettuce Harvesting System Operation Assuming a 1980 Cost Base.

Cash Flow Description	Cash Flow by YEAR OF OPERATION ($1,000)				
	1	2	3	4	5
Labor Cost Savings	2,368	2,724	3,135	3,599	4,142
Container Savings	608	654	699	766	834
Incremental Maintenance	(128)	(138)	(150)	(161)	(175)
Taxable Operating	2,848	3,240	3,684	4,204	4,801
Tax at 50.86%	(1,448)	(1,648)	(1,874)	(2,138)	(2,442)
After Tax Operating Gain	1,400	1,592	1,810	2,066	2,359
Investment Credit Carryover	21				
Depreciation Tax Shield @ 50.86%	194	127	86	33	22
After Tax Operating Cash Flow	1,615	1,719	1,879	2,099	2,381

Table 3. Present Value Analysis of the Model Lettuce Harvesting System by Year of Operation with 1980 Base.

Year	(1000)	After Tax Operating Cash Flow** (1000)	20% Earning Rate		25% Earning Rate	
			Discount Factor	Cash Flow Discounted (1000)	Discount Factor	Cash Flow Discounted (1000)
0	($1,447)		1.000	($1,447)	1.000	($1,447)
1		1,615	.907	1,465	.888	1,434
2		1,719	.756	1,300	.710	1,220
3		1,897	.630	1,195	.568	1,077
4		2,099	.525	1,102	.455	955
5		2,381	.438	1,043	.364	867
Net Present Value				$4,658		$4,106

Notes: *Adjusted for salvage of replaced equipment, and investment tax credit.

**From Table 2.

model system have not been altered from the existing system, allowing greater supervision and improved quality control. The system would place greater emphasis on coordination of product, materials required for processing, portable station movement, equipment maintenance, and personnel relations. With such a substantial reduction in labor each worker takes on a more important role in the entire process.

Summary

The model system, which is assumed to have a five-year capital equipment

life-span and to be capable of being made operational within one year, provides substantial return on investment through labor and container cost savings. The discontinued present value of the net cash flows is $4.6 million on an original investment of $1.6 million allowing a 20% interest rate on a six-year project analysis. The benefit-cost ratio is 3.84 to 1.

Alternatively, one may view the model system as capable of handling 11.3 million cartons of wrapped lettuce with more than a 50 percent reduction in total harvest labor requirements. The savings could result in a final retail price reduction of about $0.36 per carton.

Conclusions And Implications

Conclusions

In the long run, nearly all producers would adopt such a system due to the competitive nature of the head lettuce industry. Non-adoptors would exit the industry as price moved toward the lower production costs of the adoptors.

For five decades California iceberg lettuce growers have expanded production overcoming a locational disadvantage by utilizing a climate favorable to production, low labor cost, and ready adoption of technological improvements. The current problems for California growers appear to be the rising costs of energy and labor. The solution of these problems requires technological innovation in harvesting and marketing, improvement in labor productivity, and increased transportation efficiency. These energy and labor savings would come from mechanical head cutting, use of bulk bins for shipment, and automated lettuce wrapping, and are sufficient to permit the project to break even after a single year of operation.

From a labor outlook, the system reduces the number of strenuous stoop-labor jobs, increases the number of machine operator-supervisor positions, and reduces the number of people continually moving to new field locations. The system provides for better supervision and improved quality control for management as well.

The wrapped bulk-bin lettuce permits greater product quantity to be shipped in standard truck loads, 24,600 compared to 18,200 heads of naked pack (35 percent increase). The source wrapped product, more uniform and more thoroughly inspected, should have 5 to 8 percent less waste loss in transit than naked pack. Irregular heads can be processed into pre-cut product at a central processing plant, allowing grower-shippers entry into another subsector of the market. This market extension is a more stable price area not subject to the wide price variation the whole product experiences.

Implications

California production has increased due to technological advances which have shifted the supply and avoided any long term price increase. Increased capital attracted by increased returns would eventually add to increased supply creating downward pressure on prices. If the model system also encourages increases in supply, the inelastic nature of head lettuce demand may cause total revenue to fall even more than cost savings are reduced. Although industry income may not increase in the long term, the early innovators would receive increased returns until the innovation is uniformly adopted.

Lower revenue per unit of product and increased capital requirements will force non-innovators and would be entrants from the market. Thus, over time one would expect fewer, but larger firms receiving larger shares, even if industry

returns decrease. In short, despite the risks, the grower-shipper must innovate. Those exiting the industry or with insufficient resources to enter will be forced to find alternate employment of their resources.

Technological advance is the root of economic progress, as it allows society to make more efficient use of its resources. The increased output from the use of technical innovations must occur if productivity is to increase. Such progress of efficiency is a mark of a society's ability to reduce the amount of resources necessary for subsistence goods, such as agricultural products, leaving more resources for non-subsistence goods. Without technological advance the California market will be lost to other production areas less suited to iceberg lettuce production and California resources will be placed in a lower-value use. Ultimately, California's overall income level would be reduced.

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