

# Shelling Beans for Freezing

recent studies indicate proper integration of current field and plant operations can achieve reduction in vining costs

Robert H. Reed

*The following article is the fourth in a series of progress reports on efficiency in the processing and marketing of frozen fruits and vegetables. The studies are being conducted cooperatively with the Agricultural Experiment Stations in Washington, Oregon, and Hawaii and the Agricultural Marketing Service, United States Department of Agriculture.*

**One of the high-cost** stages in freezing or canning lima beans and green peas is the vining or shelling operation.

In California this usually involves one of two types of operation—mobile or stationary—and recent studies indicate substantial savings can be effected by selection of method and integration of field and plant operations.

In mobile vining a self-propelled unit operating as a combine harvester moves through the fields. Under the stationary system, the vines in the various fields of the area are cut and draper loaded into trucks for transportation to the vining station normally located in the center of a production area, where it remains throughout the harvest season.

In these studies, three methods of stationary vining—classified according to their degree of mechanization—were analyzed in relation to the amount of labor and equipment required at various rates of output and length of season.

In the least mechanized stationary operation considered—Method *A*—viners are arranged in a series of parallel pairs with approximately 6' between pairs. Vines are delivered by truck and dumped adjacent to the viner from where they are hand-forked onto the vine feed conveyor which moves them into the beater cylinder. Shelled beans drop through perforations in the revolving screen reel to a rotating canvas apron and are collected in cannery lug boxes from the viner delivery chutes. The lug boxes are picked up as they are filled and dumped by workers onto a main assembly conveyor which delivers them to a shaker-separator for additional trash separation. The beans pass through the shaker into a bulk receiving container and are placed by lift truck onto a delivery truck for transfer to the plant receiving station. Additional cleaning or washing operations and icing may occur at this point. The vines are discharged from the viner screen reel onto a straw carrier which deposits them in an ensilage trench. A standard 2-plow tractor

equipped with a loader frame assembly is used to group vines for the fork workers and to spread or redistribute piles of vines collected in the ensilage trench.

In the second and more mechanized method studied—Method *B*—labor is reduced, and the rate of output per viner is increased approximately 20% by the installation of power forks and vine feed regulators. With this additional equipment, one worker can supply vines to two viners, rather than one, and at a faster rate per viner. Other labor and equipment requirements are the same as for Method *A*.

In the third and most mechanized of the stationary vining operations—Method *C*—the equipment of Method *B* is supplemented with a side-delivery conveyor installed under each viner delivery chute. The beans thus are conveyed directly to the main assembly belt, eliminating lug-handling labor.

In the mobile vining operation, self-propelled units—operating as combine harvesters—with driver and attendant, replace the vining station labor and equipment. A beater cylinder, screen reel, apron, and frame of a standard viner are mounted on a chassis with 4-wheel-drive-and-steering and propelled by a tractor engine. A sway-bar mechanism keeps the reel and apron in a level position during operation. The viner cylinder and auxiliary equipment are operated by a standard 4-cylinder, air-cooled engine.

The viner moves through the field and picks up the vines—previously cut by the grower—by a specially designed drum which feeds them to a conveyor leading into the beater cylinder. The speed of the viner is regulated to obtain optimum pickup and feed of vines to the beater cylinder. The shelled beans are collected on a side conveyor and elevated through a pneumatic cleaner to a collection hopper. The hopper is hydraulically elevated, and the beans are dumped periodically into a bulk delivery truck for transfer to the receiving station of the plant.

## Production Standards

Production standards for labor and equipment were developed from operating and accounting record data for each of the four methods studied. The standards used in the study are related to

capacity output rates measured in shelled weight.

Standards for machine-paced jobs—hand and power forking, lug handling, and mobile unit operators and attendants—are directly related to the capacity output rate of the viners. The average output rate per stationary viner hour is 400 pounds with Method *A*, 475 pounds with Methods *B* and *C*, and 525 pounds per hour with mobile vining. Accordingly, the effective hand-forking standard—with one worker per viner—was estimated as 400 pounds per worker hour. The power-forking standard—with one worker per pair of viners—is equivalent to twice the viner capacity rate or 950 pounds per hour. Similarly, the lug handling standard is 800 pounds per worker hour with Method *A* and 950 pounds for Method *B*. As one operator per mobile viner and one attendant for every two mobile viners are required, the standard for one unit is 525 pounds per worker hour and 1,050 pounds for two units.

Trucking standards for hauling vines from the field to vining station were converted to a shelled weight equivalent and related to the radius of haul. A standard of 880 pounds per truck hour, based on a maximum haul radius of 10 miles, was developed.

Standards for bulk container attendant, lift truck and tractor operation, and

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## CALIFORNIA AGRICULTURE

Progress Reports of Agricultural Research, published monthly by the University of California Division of Agricultural Sciences.

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## SHELLING

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station cleanup are identical for each of the stationary vining methods and were estimated as 5,600, 20,000 and 3,600 pounds per man-hour, respectively. Field cleanup was estimated as 4,000 pounds per man-hour for all methods including mobile vining. Supervision for stationary vining operations consists of one crew supervisor and one general supervisor—station and field—for all levels of output. One general supervisor is required for each operating group of 10 mobile viners.

The hourly production rates were the season average rates among the vining operations studied, but they may not be strictly applicable in any given vining operation because actual output rates vary widely according to yields, amount of foliage, dampness, and labor and equipment efficiency. Because of consistently higher yields of the Fordhook variety in the Santa Maria, Oxnard, and Ventura areas, a 25% upward adjustment in the standards would be applicable in those areas.

### Variable Costs

Worker production standards can be used to estimate crew requirements to achieve any given output rate. Crew requirements were calculated for a large number of particular output rates within a range of 400 through 10,000 pounds per hour. Labor cost for each of the output rates was calculated by applying typical wage rates standardized to eliminate the effect of wage differentials

among different areas. The standardized hourly wage rates used were \$1.25 for fork workers, bulk container attendant or tailoff, cleanup, and lug handling; \$1.50 for mobile operators and attendants; \$1.60 for vining crew supervision; \$2.25 for general supervision; and \$2.50 for mobile vining supervision. Other variable costs associated with stationary vining included electric power costs at 1.2¢ per horsepower hour, \$4.25 per truck hour for vine hauling, and equipment service and maintenance at 0.5% of the equipment replacement costs per 100 hours' use. Additional variable costs with mobile operations included 65¢ per viner hour for gasoline and oil and service and maintenance at 0.6% of equipment replacement cost per 100 hours' operation.

Variable costs—with a given hourly output rate—can be estimated by applying the standardized wage rates to crew requirements and adding the variable costs associated with equipment repair and maintenance and power inputs. For example, an hourly production of 4,000 pounds with Method A—capacity rate per viner of 400 pounds per hour—would require ten forkers, five lug handlers, four cleanup workers, one lift truck operator, one tractorman, five truckers for vine hauling, and two supervisors. Applying appropriate standardized wage rates gave labor costs estimated as \$30.82 per hour. Similarly, power, equipment repair and maintenance, and vine hauling costs were estimated as \$26.34 per hour of operation. Total hourly variable cost necessary to achieve 4,000 pounds per hour using Method A was the sum of the above estimates or \$57.16.

Replacement costs for equipment were estimated at current delivered and installed prices quoted by manufacturers.

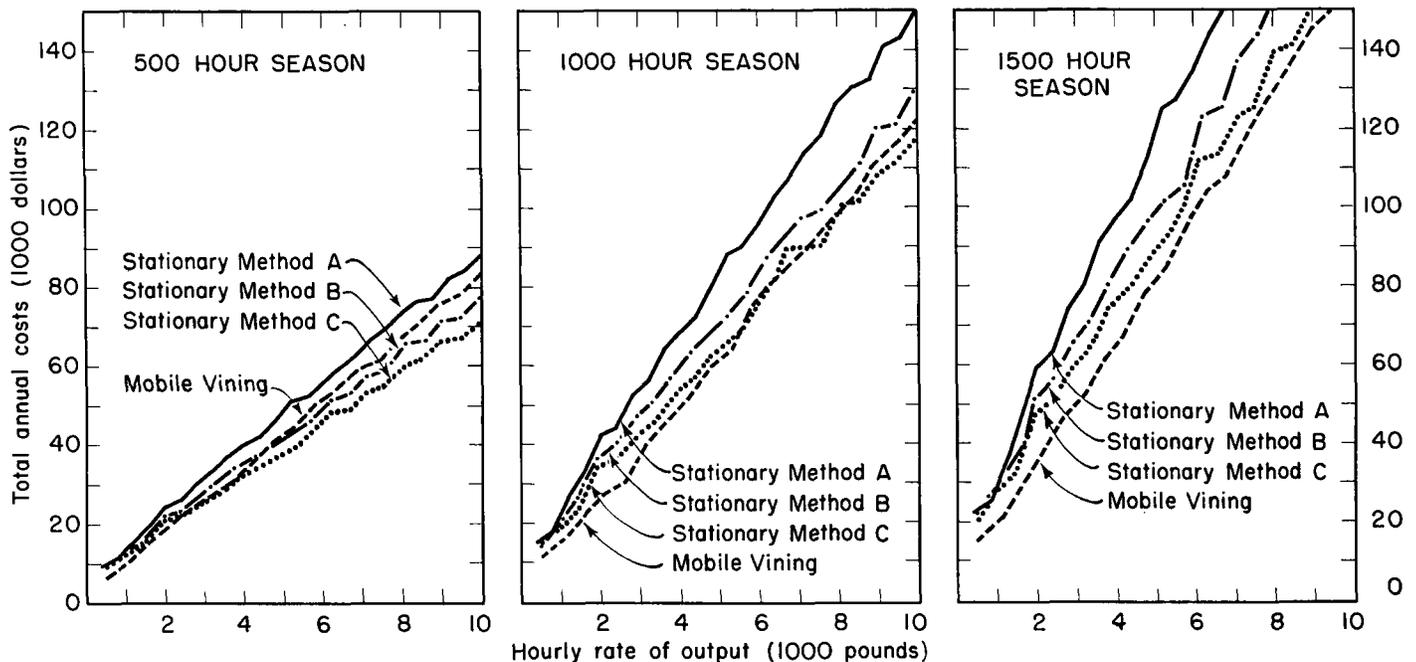
Costs of replacing major equipment items common to each of the three stationary vining methods were estimated at \$5,215 for each viner complete with strawcarrier, apron scraper, vine shaker, undercarrier separator, feed conveyor, and electric motor and drive assembly. Replacement costs of a 4,000-pound capacity lift truck, standard 2-plow tractor, and shaker-separator totaled \$9,335. The installed cost of the main assembly conveyor—which varies according to the size of vining operation—was calculated from the relation: \$347 for electric motor and drive assembly plus \$10.30 per foot of conveyor plus the cost of the belting.

Replacement costs of additional equipment required with Method B were \$365 per viner for a vine feed regulator and \$807 per pair of viners for a power fork attachment. Additional equipment costs with Method C were \$280 per viner for a side-delivery conveyor. Other equipment costs were the same as for Method B.

Replacement costs for the mobile operation were estimated as \$12,000 per viner and \$2,200 for one service and supply truck.

The machine production standards can be used to estimate equipment requirements for any specific output rate. In the previous example—4,000 pounds per hour with Method A—major equipment requirements would be 10 viners complete with auxiliary equipment, a 24" × 88' main assembly conveyor, one shaker-separator, one lift truck, and one tractor. For such an installation total outlay for

Annual costs of vining lima beans in California in relation to methods used, rate of output, and length of season, 1957.



major equipment is estimated as \$62,642. Supplemental outlays would be required for site construction, electric wiring installation, conveyor belting for main assembly conveyor, spare motor and repair parts, estimated as totaling \$3,226.

An annual fixed charge of 17% of the major equipment cost of stationary vining included: depreciation, 10%; taxes, 1%; insurance, 1%; interest on investment, 3% or approximately 5.5% of the undepreciated balance; and fixed repairs and maintenance, 2%. The annual fixed charge for site construction, electric wiring, conveyor belting, and spare parts was estimated as 10% of replacement cost. Site rent was added directly.

Applying these charges to the equipment replacement costs developed in the example gave an annual charge of \$10,649 for the major equipment items and \$415 for the supplemental equipment including \$92 for site rental. Combining the separate charges gave a total annual charge of \$11,064 for a Method A installation with a 4,000-pound hourly production rate.

The annual fixed charge for equipment used in the mobile vining operation was estimated as 19% of replacement cost. The higher percentage reflects a greater annual outlay for fixed repairs and maintenance attributable to higher costs of gasoline engine repair and overhaul and a higher rate of wear with the mobile equipment.

### Total Annual Costs

Total annual costs related to rate of output per hour and length of season were calculated by multiplying the hourly variable costs by the hours operated per season and adding the annual fixed charge. In the example, variable costs totaled \$57.16 per hour with an annual fixed charge of \$11,064. For a season of 1,500 operating hours total annual cost would amount to \$96,804—\$11,064 plus \$57.16 multiplied by 1,500.

Total annual costs for three selected lengths of season are plotted in the accompanying graph for hourly output rates varying from 400 to 10,000 pounds per hour.

Of the three stationary vining methods studied, Method C was lowest in cost throughout the ranges considered in hourly output rate and length of season. Its advantage relative to the other stationary vining methods is due primarily to the reduced labor in forking the vines and in handling the lugs of shelled beans.

Mobile vining—because of large investment cost per unit—involves relatively high annual fixed charges. However, variable costs are relatively low, principally because the vine hauling operation is eliminated. Mobile vining

becomes more advantageous as length of season—with a given output rate—is increased and the annual fixed charge spread over a larger total volume of output as illustrated by the graph. There were no savings with mobile vining in 500 hours operation, but savings became substantial in a 1,500-hour season.

High equipment costs and a short operating season combine to make vining an expensive operation. Vining cost can be lowered substantially by multiple-shift use of fixed equipment. For example, total daily requirements in a processing plant operating one 8-hour shift could be met by a vining operation of one half the plant capacity but operating two 8-hour shifts. With this arrangement in a plant of 10,000 pounds per hour capacity and a 500-hour operating season, the lowest cost—for a vining capacity rate of 5,000 pounds per hour and 1,000-hour operating season—is shown by the

chart to be with mobile vining and to amount to \$60,000 per season. However, with 1-shift vining the required vining capacity is 10,000 pounds per hour, with 500 hours of operation per season. The lowest season cost—\$71,000—occurs with stationary Method C. Comparison of the estimates of season vining cost in this example indicates an annual saving of \$11,000 with 2-shift vining operations. This assumes that differences between vining shifts in product quality, wage rates, and productivity are negligible.

The savings indicated in the example apply to the methods, production standards, and cost rates specified. Adjustment probably would be necessary in making comparisons for particular situations.

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## RETAIL

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independently owned stores received them twice a week. In four counties 19% to 29% had deliveries three times, and 44% to 55% six or more times a week. In the fifth county—Butte—60% of the independents received produce three times a week and only 20% received it six or more times.

In general, the larger the number of full-time employees in a store the more often were fresh fruits and vegetables delivered. However, this situation varied from one county to another.

In Alameda 91% and in Los Angeles 97% of the stores with 15 or more employees received produce six or more times a week. In San Diego 89% and in Fresno all the stores with 15 or more employees received produce with the same frequency.

From 78% to 94% of the stores with 7-14 employees in Alameda, Los Angeles and San Diego counties received their fresh fruits and vegetables six or more times a week. In Butte and Fresno counties about 45% of such stores received produce so often.

Stores with three to six employees

most frequently received fresh produce six or more times a week. With the exception of Butte, 49% to 72% of such stores received deliveries that often, 16% to 29% three times, and 3% to 8% twice a week. In Butte 25% of those stores received fresh produce six or more times a week, 61% three times, and 14% twice a week.

The smaller stores with one or two employees most frequently had fresh fruits and vegetables delivered three times a week—24% to 40% receiving supplies that often. From 16% to 31% received them twice and 12% to 38% six or more times a week.

In Fresno 86% and in Butte 89% of the stores with fresh fruits and vegetables had home kind of daytime refrigeration other than a sprinkling system. On the other hand, only 69% in Los Angeles, 55% in San Diego, and 45% in Alameda County had daytime refrigeration.

Considerable proportions of stores—especially in some counties—were without refrigeration for fresh produce. For the most part the stores without refrigeration were the smaller, independently owned stores in neighborhood-secondary shopping districts.

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Stores Carrying Fresh Fruits and Vegetables Without Daytime Refrigeration

County	Shopping area					Ownership			Number of employees				
	Location		Down town	Neighborhood Sec.	Isolated store	Independent			1 or 2	3 to 6	7 to 14	15 or more	
	Rural	Urban				Unaffiliated	Affiliated	Chain					
Butte	%	%	%	%	%	%	%	%	%	%	%	%	
Fresno	19.4	7.8	5.9	7.0	20.6	20.8	2.5	..	18.3	3.6	..	..	
San Diego	12.2	15.4	5.3	19.8	7.5	18.8	5.9	..	19.8	8.9	..	..	
Alameda	50.0	43.8	42.9	46.5	35.3	48.9	35.5	40.9	57.7	22.0	43.8	37.5	
Los Angeles	100.0*	54.4	55.6	53.4	75.0	64.1	57.9	20.7	73.5	28.1	23.5	9.1	
	..	31.2	30.3	31.2	25.0	46.8	24.1	18.5	46.3	20.8	17.5	12.7	

\* Only 1 store.