#### SECTION 4

# Efficiency

An unsophisticated student might make two false assumptions: first, that it is easy to define (and to measure) the efficiency of agricultural marketing; and second, that almost everyone is in favor of efficiency. Actually, the concept of efficiency is very difficult when applied to a complex problem such as the marketing of farm products. And actually the public may prefer to keep some known inefficiencies, rather than to adopt new methods — especially if the prospective improvements in efficiency might reduce employment, decrease price competition, or lead to greater concentration of economic power.

Efficiency is not the only aim of marketing, but it is a very important aim. Much of the research in agricultural marketing is for the purpose of improving efficiency. This is true of research by industry as well as by colleges and governmental agencies. This chapter will sample some of the recent work on efficiency.

The following readings start with problems of microefficiency (i.e., detailed studies of single operations or work elements). They end with problems of macro-efficiency. They cover the efficiency of firms, markets, and marketing functions. There are opportunities to improve efficiency at all levels.—EDITOR

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#### 4.1 Processes, Operations, Work Elements, and "Therbligs"

We first consider problems of micro-efficiency. The marketing process includes thousands of specific operations each of which needs analysis. Work simplification is as practical in a creamery or a retail store as it is on the farm.—Ed.

#### 4.1.1 Brunk, Max E. "An Economic Study of Celery Marketing," Univ. of Florida Agr. Exper. Sta. Bull. 445, July, 1948. Pp. 170-71, 173-74, 81-83, 91, 93-96, 97-98.

#### Definition of Terms

*Process* is a work routine usually performed by a number of individuals, each doing specific jobs to contribute to the end product of the process or one person doing a series of different jobs, all of which contribute to an end product. A flow-process chart shows the flow of a product through the various jobs in assembly, together with any side or contributory assembly.

Operation is a work routine usually performed by one person or teams of persons contributing to the completion of some segment of a process. Operations usually consist of a series of hand or hand and machine movements.

Work element is a work routine consisting of one segment of an operation. One person usually performs a number of work elements in completing an individual operation.

Therbligs are the fundamental elements of performing any work routine and may be defined as the basic divisions of accomplishment. Therbligs may involve either physical or mental activity.

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... Another example might be the process of preparing celery for market. This process consists of a series of jobs, one of which is packing the celery in crates. It requires two operations to perform this job. One worker picks out a given size of celery while another worker places the sized celery in the crate. The operation of sizing, however, is made up of several work elements: (1) select stalk, (2) place on table. In turn, the stalk was placed on the table by a series of therbligs such as: (1) transport empty hand to stalk, (2) position hand, (3) grasp, (4) transport load, (5) inspect, (6) position, (7) release load.

After the celery emerges from the washer it is ready for sizing and packing. Most washhouses have from nine to 12 packing tables on each side of each chain. A sizer and packer work as a

team at each table, the sizer working next to the chain. The table nearest the washer is used for the largest size celery and the smallest size celery (usually size XX) is packed on the last table along the chain.

The job of the sizer is to select a particular size of celery from the chain and to place those stalks on the packing table. Using the stalks selected by the sizer, the packer fills the packing crates following a standard packing pattern which has been adopted for the various sizes.

Of the nine firms studied in detail, seven used the system described above. The labor required per 10,000 stalks ranged

 TABLE 32

 Comparison of Time Required to Sort and Pack 10,000 Stalks of Celery by Nine

 Different Firms, Florida, 1944 Season

		Hours of Labor per 10,000 Stalks		
Area	Firm	Sorting and Packing	Total Field and Washhouse Root Trimming and Stripping Time	
Sanford	C	21.2	32.2	
	F	11.5	38.4	
	D	24.1	40.0	
Sarasota	P	21.0	47.2	
	N	21.4	35.4	
	O	22.9	38.7	
Belle Glade	I	23.1	26.9	
	M	17.0	43.1	
	J	26.0	29.7	

from 21 to 26 hours for the seven firms. Firm M, which spent 17 hours of sorting and packing labor per 10,000 stalks, . . . followed the practice of having one sorter and one packer work on two sizes, particularly the 2's 21/2's, 8's 10's and XX's. The volume of any one of these individual sizes was not large enough to keep one sorter and packer occupied over 50 per cent of the time. Because firm M took advantage of an opportunity to adjust working conditions to the job to be done, only 17 hours of labor were used per 10,000 stalks.

\* \* \*

Firm F made a large saving of labor by combining the jobs of the sorter and packer. Each worker was both sorter and packer. As stalks were selected from the chain they were placed directly in the crate. When the crate was filled it was pushed aside and an empty crate was taken from the crate chute. . . . With a little training the workers soon learned to place a new crate with one hand and at the same time sort from the chain with the other.

Managers of many firms refused to try this faster method ... [because they thought] that a worker could not sort out the proper size, concentrate on packing and at the same time get the correct number of stalks in each crate. The managers would not consider the possibility of slowing down the packing chain to give the workers more time to sort out the proper sizes and place the stalks directly in crates.

... a detailed study was made of the packs put up by 15 firms. Two of the firms packed directly from the sorting chain. Results indicate that there is little need for slowing down the sorting chain to obtain a good, accurate pack by packing directly into the crate from the chain.

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After the crate is filled a paper liner is drawn over the top of the stalks and the lid of the crate is pulled up into position for closing. The size is then marked on the crate with a crayon or rubber stamp and the crate is set on a conveyor.

In many houses a special employee stamps the crates, pulls the lid into position for closing and sets the crate on the conveyor. The crate moves to the end of the conveyor where it passes over a trip-switch, which stops the conveyor. As soon as the crate is pulled on the closing table, the switch is released and another crate moves down on the conveyor, while the first one is being closed.

Practically all crates used in the Florida celery business are the wire-bound (Howard) crates. These crates have four wires running around the crate for reinforcement. These same wires serve as hinges on the back of the lid and as clasps on the front of the lid. A number of operation analyses were made of crate closing. The procedure in all cases was essentially the same. After the crate was pulled on the closing table the right hand straightened the paper liner while the left hand worked the lid into place. A closing tool, called a "rocker," was palmed in the right hand. This tool has a large wooden handle. While the left hand held the lid in position the right hand pounded the

left end of the crate with the handle of the rocker until the end of the crate fitted under the lid. The rocker was then fitted into the wire loop, which was tightened and fastened. The same procedure was followed on the right end of the crate, after which the two center wires were tightened and closed.

The most difficult part of the procedure is pounding the heads of the crates into position so that the lid will close over them. The packed celery in the crate causes the heads to bulge outwards. Pounding on the heads not only bruises some of the celery in the crate but also frequently splinters some of the veneer wood and materially weakens the crate. The operation chart of this procedure revealed that the left hand was engaged primarily in holding the crate. This suggested a holding device. The right hand did most of the work, which consisted of pounding the heads into position. This suggested a clamp which would also serve as a holding device. The problem was taken to the University of Florida Engineering Experiment Station. An engineer constructed a model which was taken into the field for trial. In testing the device it was discovered that the clamps which held the sides of the crate would, with a minor adjustment, also automatically position the crate on the closing device. A second model was built which was adjustable for minor variations in the sizes of crates. This model was tried out successfully in a number of washhouses and the specifications for constructing the device were then released.

The operation of closing crates is greatly simplified by using this device. The crate is pulled on the table by hand.<sup>1</sup> Depressing the foot pedal of the device places the crate in position, draws the heads into place and holds the crate while the wires are fastened from the left to right. The foot pedal is then released and the crate set off the table.

It was noted, in making the original operation charts for crate closing, that practically all the workers closed first the left end and then the right end, leaving the two wires around the center of the crate until last. The workers could give no reason why they closed the wires in this particular order. It was found that the crate would close easier by closing the wires from one end to the other in order. By so doing, less of a bulge was left

<sup>&</sup>lt;sup>1</sup>Consideration was given to extending the conveyor over the device so that the crate would automatically stop in position, but this idea was abandoned because it prevented the next crate from being moved into position while the first crate was being closed and thus caused unnecessary delay.

in the center of the crate. Consequently, the last end was easier to fit over the head of the crate and fasten.

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Need of Improvements in Washhouse Arrangement. The arrangement of present-day washhouses is not conducive to the efficient use of labor. The efficiency with which many operations can be performed depends not on the ability and skill of the individual operator concerned but rather upon the output of some previous operation. This is true of most assembly-line processes.

In the case of celery washhouses each side of a stripping and packing chain constitutes an assembly-line process, within which there is only a limited amount of flexibility for balancing the amount of work among the various workers. The method was first established by small firms using only one chain. In recent years many houses have expanded by adding a second, third or fourth chain. A firm using four chains, therefore, has eight separate assembly-line processes, each with only a limited flexibility for balancing the amount of work each individual in the line has to perform and, in addition, allows for no flexibility between chains.

Packers and sorters constitute the great bulk of washhouse labor and, as explained previously, the accomplishment of all the sorters and packers depends on the team of sorters and packers which has the largest volume to handle. Likewise, the accomplishment of the team is automatically limited by the output of either the sorter or the packer, depending on which is the faster.

The individual who closes the crates can close only as many as the packers on one side of a chain pack. A four-chain house employs eight crate closers, each of whom is engaged in productive work for only part of the time.

The present system of sorting out sizes on the packing chain, placing the packed crate on a conveyor to be mixed up with other sizes, only again to be resorted by size in a huge sorting room, constitutes a paradox. The sorting rooms of many washhouses are as large as the space occupied by the balance of the plant.

The lack of flexibility between individual chains could be overcome by handling all celery on one rather than on many assembly lines. One possible way this might be done would be to have all the celery deposited on a common stripping and

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sorting chain. The individual sizes sorted from this chain would be placed on cross conveyors so that all of one size would pass to a common point for packing. Such a system would allow for a maximum of flexibility between the number of sorters and packers, would help overcome the difficulty of the first packer packing heavier crates, and would result in the automatic sorting of packed crates of a common size and thus eliminate the need of a sorting room.

On many occasions during this study 16 workers were observed in a four-chain house sorting and packing sizes 10's and XX's, when the total number of stalks of these sizes on all chains combined was not large enough to keep over two persons fully occupied had they been on a common chain.

Much experimentation is needed before plans for such a revised arrangement could be completed. A "pilot" plant would have to be constructed, experimented with, and probably rebuilt many times before such plans could be considered complete. It goes without saying that such a project carries beyond the scope of this study, other than that the findings of this study indicate the problem.

An example of work simplification is given in this discussion of the handling of eggs.-Ed.

4.1.2 Zuroske, C. H. "\$3000 to \$6000 Payroll Saving Possible for Egg Coop," Work Simplification News Letter, No. 21, Purdue Work Simplification Lab., Nov., 1950. Pp. 6-7.

The objectives of a recent egg handling methods study were to reduce cost and to test the applicability of selected techniques of scientific management to egg marketing processes. This was a pilot study to serve as a guide to methodology for the more extensive study of egg marketing which is anticipated.

In egg marketing, an important area of work is assembly, handling, grading, and cartoning. A large cooperative plant was selected for the pilot study. The research procedure was to observe each major job and to describe it as completely as possible. Expenditure of non-productive effort was identified by checking each job for its contents and comparing the manner of accomplishing the job with established criteria for effective work.

**Results.** The usual number of workers in this plant at the time of observation was 40. This was made up of 29 candlers and 11 materials handlers. Almost without exception each worker was expending energy equal to that which would ordinarily be expected with standard work rates. Expenditure of this energy, however, did not always result in an optimum output rate.

In general the work methods developed in this plant were commendable. Significant potential cost reductions coming from this study appeared to be in the following areas:

- 1. Supplying candlers with eggs. This job, currently done by two men, could perhaps be accomplished by one or one and one-half workers.
- 2. Sealing and segregating cases of eggs. This is currently a two-worker job. This might be done by one or one and one-half workers. The jobs of supplying eggs and sealing and segregating might be combined into a three-worker combination saving one worker.
- 3. If the candling booths can be improved for a small increase in output, say, 5%, likely the present staff in other operations could take care of the increased output without adding help. This implies that each operation involved would be simplified some.

With changes involving a minimum investment it is estimated that an annual payroll saving, or equivalent economy in terms of increased output per worker, amounting to \$3000 to \$6000 could be made.

In the report to the cooperator a detailed description and appraisal was made of each job. Wherever a principle of effective work was in question a possibility for improvement was indicated. These suggestions were only tentative as management and workers concerned could, no doubt, offer more and better possibilities for improvement.

> Much more attention has been given to the simplification of operations in farming than in marketing. In the field of marketing more work has been done on processing than on distribution. But it is well to remember that some of the largest costs are in city distribution — especially in retailing. These operations can be simplified too.—Ed.

4.1.3 Harwell, E. M. and Shaffer, Paul F. "The Check-out Operation in Self-Service Retail Food Stores," U. S. Dept. Agr., Agr. Inf. Bull. No. 31, Jan., 1951, Pp. 1, iii-iv.

The check-out operation plays an important part in retail self-service food stores. In all stores studied in this project, the check-out function accounted for more than 20 per cent of the total man-hour requirements. Its importance is further emphasized by its accepted position as the common bottleneck in the store during peak periods of the week. It is not uncommon for self-service food stores to handle from 60 to 70 per cent of their weekly volume on Friday and Saturday. Peak periods within

these high volume days place an immense load on check-out operating personnel and equipment. It is an accepted fact in the industry that store sales volume is directly affected by the rapidity with which customers are accurately processed through the check-out operation. In stores where automobile parking facilities are limited, increased service at the check-out operation during peak periods may lead to increased volume through a larger turn-over in the parking areas. With the advent of selfservice meat and produce merchandising, the cashiers at the checkstand often become the only personal contact with the customer. This further increases the need for a pleasant reaction by the customer to check-out personnel and equipment.

The purpose of the study was to evaluate the check-out operation to determine the advantages and disadvantages of the more common methods and types of equipment now in use, as well as to develop and evaluate improved methods and equipment which might enable the industry to give improved customer service at the same cost or at a lower cost.

Detailed studies were made on several types of equipment and were carried on in nine stores in two retail food store chains. Observations were made of the check-out operation in stores located in various sections of the country. The scope of the study consisted of an analysis of all work associated with the movement of the merchandise from the time it was brought to the check-out location until the complete order was checked and bagged (or boxed), ready to leave the store.

Summary. A new type grocery check-out counter has been developed which increases by 38 per cent the number of orders checked out per hour, as compared with the usual methods. Cost per order decreased by 26 per cent. The new counter, called the Redi-chek, gave the highest production of the 5 types of equipment that were analyzed and time-studied during the project. Forty-four orders per hour were handled at a labor cost of 2.3 cents per order with 1 person operating the equipment; 61 with 2 persons, and 67 with 3 persons. More than 20 per cent of total labor in all stores studied was used in the check-out operation, indicating a potential for considerable saving.

The Redi-chek was designed to reduce the number of times the cashier handled each item. The following features were incorporated in the equipment: (1) The sorting of merchandise was eliminated; (2) the order was rung up and bagged simultaneously (the bag was placed in a specially constructed well which held the mouth of the bag open); (3) a 7-foot conveyor belt was used to move the merchandise to the cashier's position; (4) an automatic coin changer was incorporated in the equipment to simplify change-making; (5) two additional bagging wells were added, so that when a bagger was added to the equipment, he could bag items with both hands simultaneously; and (6) a bag rack was installed behind the counter to hold completed orders. The Redi-chek was operated by one, two, and three persons.

Another system, called the Simplex, was developed and tested. It likewise processed 44 orders per hour. It was particularly adaptable for stores which do not have definite week-end sales peaks. The cashier removed the items from the baskart and placed them in a bag — recessed in a well — simultaneously with the ring-up. An automatic coin changer was used. This counter was limited in operation to 1 person.

A single operator, using conventional equipment with merchandise presorter, produced 32 orders per hour at a labor cost of 3.1 cents per order. This was the lowest rate of production and highest cost of any type of equipment studied. This performance can be explained by the physical handlings involved in the operation: (1) As the order was sorted; (2) when the items were rung up on the register; and (3) when the merchandise was bagged. Other handlings were necessary when the cashier unloaded the baskart or when she used the presorter.

When an additional person was used on the conventional equipment, production was increased by 52 per cent. This contradicts the belief, frequently encountered during the study, that a cashier and bagger working together would produce more than two cashiers working alone. Labor cost for the two-man operation was 4.1 cents per order.

A continuous belt conveyor check-out was also studied. It contained an 18-inch-wide rubber belt, running the entire length of the equipment (14 feet). The unit was operated in much the same way as the conventional equipment, with the belt conveyor replacing the merchandise presorter for the one-man operation. The unit provided for operation by as many as four persons. A crew of this size produced 62 orders per hour, but at a high cost per order (6.4 cents). These rates compare with the three-man operation of the Redi-chek which handled 67 orders per hour at a cost of 4.5 cents per order.

For the one-man operation, a disc-type counter, which uses a revolving disc to move merchandise to the cashier, was 11 per cent more productive than the conventional equipment. With a three-man crew, the disc-type check-out counter almost equaled the production of the four-man operation on the continuous belt conveyor unit.

The automatic coin changer contributed to increased checkout production and improved accuracy in making change.

Motorized departmental keys on the cash register improved performance of the ring-up part of the operation by 4 per cent and facilitated elimination of the sorting of merchandise.

Of considerable importance is the fact that a change in equipment to the Simplex or the Redi-chek unit is not necessary in order to obtain improved performance in the check-out operation. Most other types of check-out counters now in use can be altered, at small cost, to eliminate the sorting of merchandise and to improve the bagging operation. Several types of equipment now in use, such as the disc-type unit, can easily incorporate the cashier's bagging-well to make possible the simultaneous ringing up and bagging of merchandise.

Work simplification research often involves the timing of particular operations. An interesting technique in this field is the *ratio-delay* method.—*Ed*.

#### 4.1.4 Sammet, L. L. and Hassler, J. B. "Use of the Ratio-Delay Method in Processing Plant Operations," Agr. Econ. Res., Vol. III, No. 4, Oct., 1951. Pp. 125-27, 183.

In a particular plant the operations often involve many different job classifications and many workers. To analyze the operations it may be necessary to obtain data as to the labor and equipment requirements in each job category. This may require an estimate of the time expended per work unit and of the proportion of time spent in productive work, in a delay or idle status, on work of another category, etc. It also may be essential to obtain the pattern of movement for materials transported by hand truck or fork truck — that is, the transport route for each type of material, the number of units moved per trip, and the number of times the material was moved. The most logical way to obtain this pattern is by observation of the workers involved.

For many jobs, the time requirements per work unit are most easily obtained by time study, but this method is not well adapted to tasks in which the job elements are not well defined — for example, checking packed boxes in a fruit-packing plant to ascertain the size and number of fruits per box. Moreover, the use of the time-study method to obtain data such as the proportion of delay time is unduly expensive if many jobs are to be studied. In fact, if the plant operations are seasonal, as is often the case for marketing facilities, there may be insufficient field time for obtaining these data by time study. Similar handicaps apply to the production-study method.

Thus, under suitable conditions, the ratio-delay method is useful in economizing on field time required for estimating delay proportions and in establishing unit-time requirements for the less well-defined jobs. A modification of the ratio-delay method also is applicable to the problem of defining the pattern of flow in materials handling.

Procedures in Ratio-Delay Studies. The ratio-delay method is essentially a sampling process which involves: (1) a machine or worker whose activity is divided into several categories, (2) a large number of instantaneous and, for practical purposes, random and independent observations of the work, and (3) the theory that the ratio of the number of observations in any one category to the total number of observations will yield a reliable estimate of the ratio of time expended in that category to the total time. The process can be visualized more easily, perhaps, by first considering how observations are made in the field.

As a preliminary step, the work performed at each work station is studied and a written summary or job description of the operations is prepared. The observer thus familiarizes himself with the details of each job and is prepared to classify properly the events to be noted in the ratio-delay study. A schematic plant lay-out may be drawn to record the locations of the work stations to be observed and for use in planning the route to be followed by the observer. Tours of the plant may be made over this route and on each tour the activity of the worker at each station may be classified.

To avoid bias in classifying the observations, they should be made on an instantaneous basis, with care to eliminate any tendency to anticipate what the work status should be or unconsciously to exercise a preference for recording the work status in one way or another. For example, a kindhearted observer might unconsciously prefer to record a worker as "working" rather than "idle." The kind of observation desired may be described as that resulting if the observer were to wear special goggles equipped with a camera shutter. If the shutter were operated

the instant the work station was visible, an instantaneous observation of the work status would be obtained.

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Applications in a Packing-House Study. To indicate how the ratio-delay method may be used in plant studies, several illustrations are given of its application in a current study of deciduous fruit-packing houses in California. This work has included an intensive study of operations in 22 plants in which the number of job classifications varied from about 12 to 45 and the total number of workers per plant ranged from 25 to 180. The ratio-delay method was employed to obtain three types of data: (1) The proportion of "delay" (nonproductive time) in relation to total working time. (2) Time requirements per work unit for specific jobs. (3) The flow pattern in materials handling.

The Proportion of Delay Time. — In the simplest case, this involves a classification of the observations into only two categories. The data given in Figure 2, for example, would be grouped into two classes, "working" — 57 observations — and "not working" — 21 observations — and the delay proportion computed as the ratio of delay observations to total observations. If the estimated delay proportion is represented by p, this ratio in the example is:

# p = 21/78 = 0.269

As it may prove desirable to have information regarding the causes underlying the total delays observed, subgroups of delay observations might be obtained. Thus, in the data in Figure 2, 18 observations were recorded under "break for lots" and the proportion of observations in this category is:

## p = 18/78 = 0.231

The foregoing ratios of instantaneous observations are estimates of the proportions in which the total time was divided. Thus, we estimate that of the total time about 73 per cent was actual working or productive time and 27 per cent was totaldelay time. Delay due to break for lots is estimated as 23 per cent of the total time.

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In ascertaining delay proportions, the ratio-delay method usually will be less costly to apply than either the productionstudy or time-study method. In the plant studies here cited, for example, the field time required in the ratio-delay study is estimated to have required 80 per cent less time than would have been necessary to obtain a one-day production study of each job. This estimate is greater than has been reported in other studies; estimated savings of 33 to 70 per cent have been noted in other reports.

The ratio-delay sample may be more representative than a time study or a production study, for it may easily be composed of an aggregation of observations taken over a period of days or weeks (assuming no essential changes in the plant organization or working conditions during the period of observation) and thus may reflect typical conditions more accurately than would isolated time studies or a production study confined to one day.

If made on a department or plant-wide basis, the ratio delay study can provide, in a sense, a simultaneous measure of delay at all points and so is an excellent device for indicating how effectively plant operations are integrated, and at what points improvements in work methods to eliminate delays would be most beneficial. These relationships would not be so clearly revealed by a succession of isolated production or time studies.

The ratio-delay data may be less biased than the productionor time-study data from the standpoint of the worker's reaction to observation, since the worker is under observation in the ratiodelay study for very short periods. Even so, in the particular study referred to in this paper, some worker reaction was noted in a few instances. The reaction usually was in the nature of a make-work tendency. An experienced observer, however, can offset abnormal worker reaction: For example, he can obtain a "flash" observation on entering the work place; he can make his observation after having passed the work place; or he can observe from across the plant.

The ratio-delay method shares a common handicap with the production-and time-study techniques — that is, the bias introduced by the rate at which a particular individual works. It is conceivable, and not unlikely, that delay time is observed for some individuals whose output is governed by a production line only because they work at an abnormally rapid rate and thus work themselves out of a job. Conversely, the bias for a slow worker would be in the other direction. Owing to the nature of the ratio-delay study, any such bias appears difficult to eliminate. But if observations on several workers are aggregated to obtain the ratio-delay proportion, the effect of rate-of-working by an individual would tend to average out.

There is still room for a great deal of research dealing

with operational efficiencies in processing, transporting, storing, and distributing farm products. The economist must work closely with the engineer in this field.—Ed.

#### 4.1.5 Brunk, Max E. "Marketing Research in Operational Efficiency," Marketing Margins and Efficiency, A Report of the Marketing Research Workshop, U. S. Dept. Agr., July 9 to 19, 1950. Pp. 37, 38-39, 42-43.

It is safe to say that most of the systematic application of methods engineering techniques to marketing problems has been confined to a relatively few isolated instances where individual marketing agencies have maintained their own methods-study departments or where they have called on industrial engineers to do special jobs. Sometimes the work has not been fruitful because the engineer has not had a full appreciation of either the economics of the marketing job or of the heterogeneous characteristics of agricultural products. Experience indicates that in agricultural marketing the engineer's know-how can be effectively combined with the conventional methods of the economist in determining such things as the relationship of inputs and outputs; more effective means of materials handling; desirable plant and market location, layout and design; economics of scale and integration; and more effective work routines and equipment design.

From the standpoint of both the work itself and the techniques used to analyze the work, motion and time study can be divided into two broad classes: (1) work involving the movement of workers or materials from place to place; (2) work in one place. The former involves time and travel or plant-layout studies and the technique of study is known as "process analysis." The latter, work in one place, involves the study of body and/or machine motions. Macro-movements are studied by means of "operation analysis" and micro-movements by means of "micro-motion analysis." The mental processes in making operation and micromotion analyses are the same. The tools used for measuring and recording the movements are different.

My assignment here was to make an appraisal of marketing research in operational efficiency. Thus far I have made this appraisal in a positive sense. Actually it is a criticism of marketing research to the extent that the approaches described have not been used on the many opportunities that do exist. But I should not leave the subject without listing a few critical comments about the techniques of motion and time study as they have been applied. 1. In general I would say that there has not been enough coordination of the efforts of economists, engineers and production specialists in attacking a common problem. Effective work in operational efficiency requires the combined efforts of all three.

2. There has been a tendency to study small detailed jobs before examining over-all processes. This frequently results in wasted effort because a change in the process frequently eliminates the small detailed job. In general, the procedure in making operational studies should be from the over-all method down to the detailed work elements rather than the reverse.

3. There has been a tendency to ignore the quality of the product produced when changes in method are recommended. It is practically impossible to change the method of work without influencing the quality of the product. Measuring a quality change is sometimes more difficult than making the methods study. It may even involve consumption studies.

4. In drawing inferences between methods of work there has been a tendency to ignore differences in rates of worker activity. There are many ways of "leveling." More research is needed to determine better ways but it should also be recognized that almost any method of leveling is better than none. The same thing can be said about adjusting for plant capacity. Professor R. G. Bressler at California has done some excellent work on this subject and all researchers should be familiar with it.

5. There has been a tendency to do too much "efficiency experting." Management and the workers themselves should participate in the development of improved methods. The "Work Simplification" approach offers great possibilities. H. B. Hood and Sons, milk distributors in Boston, maintain a large motion and time department and have effectively employed the "Work Simplification" approach.

6. There is need for improved research techniques in methods analysis. Little new has been advanced since the principles were first established by Taylor and the Gilbreths.

#### 4.2 An Efficient Business Unit

Consider next the efficiency of an individual processing plant, warehouse, retail store, or any other business unit. How big should it be? What equipment and machinery are required? How should it be operated?

Surveys of agricultural processing plants have generally shown high inverse correlations between volume of business and average cost. This in itself does not mean that all plants should be big. A big plant would be very inefficient if it could not get the raw materials to enable it to operate at a reasonable percentage of its capacity. But assuming adequate supplies and adequate market outlets, the size of a plant is an important factor in its success.

The following excerpt is concerned with economies of scale.-Ed.

#### 4.2.1 Henry, W. F., Bressler, R. G., Jr., and Frick, G. E. "Efficiency of Milk Marketing in Connecticut, 11. Economies of Scale in Specialized Pasteurizing and Bottling Plants," Storrs Agr. Exper. Sta. Bull. 259, Univ. of Conn., June, 1948. Pp. 8, 10-13.

(a.) Cost Curves for Individual Plants. In any milk plant there are particular technical conditions that control and determine the relationship between inputs of productive factors and outputs of products. These conditions include the construction and arrangement of the plant and equipment, the efficiency of various pieces of equipment and the integration of operations, and the skill of both laborers and managers. Given these conditions, it will be possible to describe inputs in two general categories: first, those that are primarily a function of time and independent of the volume handled; and second, those that vary with the volume handled. This description may be called the physical production function for the plant in question.

Such production functions are basic to the determination of cost relationships, for costs are obtained by applying suitable prices and cost rates to the physical inputs. Plant and equipment will thus be reflected in fixed capital investments, and these in turn will be converted into *fixed* costs through the application of suitable rates for interest, depreciation, insurance, and taxes. Inputs of fuel, labor, electricity, and other variable items will appear as *variable* costs when they are multiplied by appropriate unit prices and wage rates. Together, these will give a relationship or curve describing the effects of volume changes on plant costs.

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Since cost curves are derived from input-output relationships by applying suitable prices and cost rates to the inputs, it follows that any physical production function will give rise to a whole family of cost curves, each differing because of the particular prices and rates used in calculating fixed and variable costs. . . . If changes are limited to the rates applicable to fixed costs, the effects will be to raise or lower the level of the total cost curve. On the other hand, if the changes are in the prices of variable factors, the effects will be to change the general slope of the curve, with steeper curves resulting from higher prices. Finally, there are all of the possibilities involving both fixed and variable elements, or both the level and the general slope of the cost curve.

Mention of the multiplicity of cost curves raises a very important point with respect to production functions and to cost curves. To be meaningful, these curves and functions for a particular plant must refer to the greatest possible output from a given input and to the lowest cost for that output. It goes without saying that there would be a host of less efficient organizations for this plant, and that each would be reflected in higher cost curves, but these would be "nonsense" combinations. A given plant output that could be obtained by using three men could also be obtained with six if the three added men merely reported for work and sat around the plant. In a like manner, it would be possible to use much more fuel by careless firing and by running the boiler at full capacity even when it was not required, and so to increase the level of the cost curve. But these are obvious inefficiencies that do not represent the production possibilities of the given plant under the stated conditions.

(b.) The Curve Showing Economies of Scale. The foregoing discussion has focused on the operation of a given plant, where many of the factors of production are fixed. In many situations, however, it will be desirable to consider all factors as variable, and to determine the costs for a series of plants similar in type but differing in size or capacity. Cost curves of this type are illustrated by the broken lines in Figure 2. . . If average costs at the most efficient volumes are lower for large than for small plants, then it is apparent that there are savings or economies of large scale operation. Eventually these economies may be dissipated or more than offset by diseconomies. This is the situation indicated in the diagrams.

Under most conditions, it will be possible to have plants of many different sizes. If cost curves were obtained for a number of these, envelope curves could then be drawn tangent to these individual plant curves as shown in the diagram. These will show the levels of cost that could be obtained for any volume with the plants designed to handle that volume. The individual plant curves show the changes in costs that accompany variations in volume within a given plant; the *envelope* or *economies of scale* curves show the cost changes that will accompany changes in the size of plant, when plants are operated efficiently and without



Fig. 2. The relationship between short- and long-run plant cost curves; A — in terms of total cost; B — in terms of average costs. The broken lines represent short-run costs, while the solid lines represent long-run costs — the curves showing economies of scale.

excess capacity. Because such curves show the costs that may be achieved under optimum organizations and not those that may characterize an actual but inefficient system, they have sometimes been called planning curves. The following pages attempt to derive cost curves for a group of city milk plants with relatively wide variations in capacity, and from these to construct a curve showing economies of scale.

3. Research Procedures. Several methods have been used by research workers in attempting to approximate the economies of scale curves. Perhaps the most common approach has been to determine average costs and volumes for each of a group of sample plants. These cost-volume data are then summarized in a table or diagram to show the average regression between plant volume and costs. Unfortunately, such average regressions combine and confuse cost changes that result from the more complete utilization of a plant of given scale with the cost changes that accompany changes in scale. As a consequence, it is a correct representation of neither.

This difficulty may be avoided by selecting a sample of plants that are well designed and operating approximately at capacity. In view of the prevalence of excess capacity, however, such a direct approach may not be as practical as might first appear. Maladjustments within the sample plants, both with respect to the integration of the several processes and items of equipment and to the adjustment of volume to capacity, will usually make some modifications necessary. These will take the form of budgetary or synthetic adjustments to actual plants in order to approach hypothetical organizations meeting the required conditions.

In the present study, the research has been based almost entirely on such syntheses. Plant designs and equipment lists have been obtained from dairy plant experts. These have been used to estimate investments and fixed costs. Job analyses have been used to indicate the amount of labor needed. Other variable costs have been projected on the basis of known cost data and on the principles of physics and engineering. These elements finally have been combined to indicate the relationships between costs and volume for each of a group of plants with capacities ranging up to 4,800 quarts daily, and the plant or short-run curves then have been used to determine the long-run relationship showing the economies of scale.

It will become apparent in the following pages that the major job of estimating cost relationships is the determination of the

basic physical relationships. Most of the work is technical rather than economic but, as explained in the preceding section, these technical relationships must be known before the appropriate cost relationships can be developed. Theoretically, the economist takes these technical functions as a part of his given data; practically, it is frequently true that appropriate functions are not available and must be developed as a part of the job of economic analysis. This is the case in milk distribution, although many phases of the following syntheses have been possible only because of a satisfactory background of technical knowledge.

> Size of plant is only one factor. Several other factors were covered in a recent study of cotton manufacturing.— Ed.

#### 4.2.2 Howell, L. D. "Costs of Manufacturing Carded Cotton Yarn and Means of Improvement," U. S. Dept. Agr. Tech. Bull. No. 1033, Aug., 1951. Pp. 7, 2, 3, 4, 5.

Purposes of Study. The main purpose of this study was to show what appears to be the most feasible means of increasing the efficiency and of reducing the costs of manufacturing carded cotton yarns. Intermediate purposes were: (1) to prepare detailed specifications and to indicate operating results for Model low-cost mills designed to manufacture specified kinds of carded cotton yarns for use as a standard or basis of comparison; and (2) to assemble and analyze detailed cost data for a representative sample of 15 carded cotton-yarn mills to show the influence of the several factors on efficiency and unit costs at each stage or process of manufacturing specified kinds of carded cotton yarns under actual operating conditions. The specifications and operating results for Model mills and the results of the analysis of cost data for representative mills under actual operating conditions are intended for use in indicating the adjustments needed to increase efficiency and to reduce costs. The results of this research are given for the direct use of manufacturers of carded cotton yarns and indirectly for the benefit of the cotton industry as a whole, including farm producers and consumers of cotton products.

Detailed specifications were prepared for so-called Model lowcost mills for manufacturing typical kinds of carded cotton yarns. They show the most desirable buildings, machinery and equipment, floor plans, labor requirements, draft programs, and production data for such mills. The grade and staple length of the cotton to be used are specified and detailed costs for the processes and operations are developed. The specifications are based on modern buildings and machinery throughout, and they apply to establishments of about 10,000-spindle units operating 2 shifts per day or 80 hours per week. They are also based on prevailing wage rates in the area of the mills surveyed and apply to known machinery that has proved itself to be practicable.

Detailed cost data for a representative sample of 15 carded cotton-yarn mills were assembled and analyzed to show the influence of the various factors on costs of labor, overhead, and other items, at each stage or process of the manufacture of specified kinds of carded cotton yarn under actual operating conditions. Wide variations were found in kinds and conditions of buildings and equipment used and in organization and operation of the plants, but, taking the plants as a whole, none of the 15 mills surveyed equals the Model mills in buildings, machinery, or layout, or in simplicity of operations, although some of them approximate the Model mills in some particulars. The mills surveyed ranged widely in size and in number of counts of yarn spun, whereas the specifications for Model mills apply to plants of about 10,000 spindles, each mill to concentrate on the manufacture of only one count of yarn.

Total costs of yarns for the 15 mills surveyed, adjusted to 2 shifts per day or 80 hours per week, are substantially higher, in most instances, than those indicated for Model mills. These costs for 10s hosiery yarn, exclusive of selling expenses, ranged from 52.03 cents per pound to 55.75 cents, and averaged 53.28 cents. for the mills surveyed, compared with 50.06 cents for the Model mill. In the case of 20s hosiery yarn, these costs ranged from 57.30 cents to 62.46 cents and averaged 58.74 cents, for the mills surveyed, compared with 55.97 cents for the Model mill. Differences in these costs for other yarns ranged from about the same as, to somewhat less than, those for 10s and 20s hosiery yarns.

Differences in labor and overhead costs by departments for the mills surveyed indicate possibilities for improvement at each stage of processing. For 10s hosiery yarn, for example, total labor and overhead costs for the highest cost mills surveyed exceeded the corresponding costs indicated for the Model mill by amounts ranging from about 81 per cent for spinning to more than 200 per cent for handling and storage and for fly frames. . . .

The possibilities of bringing about reductions in labor and

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overhead costs for carded cotton yarns by amounts approximating the differences shown between actual costs for the mills surveyed and those indicated for Model mills appear to depend upon whether the costs indicated for Model mills are attainable under actual operating conditions. Data on labor and overhead costs by departments show that costs for the individual mills surveyed in many instances approached closely enough those for the Model mills to indicate that the costs shown for Model mills are at attainable levels under the conditions specified.

The principal factors contributing to maximum production per man-hour include the use of suitable kinds of cotton, the maintenance of good working conditions, a steady flow of work, the right type and quantity of modern machinery well maintained, a lay-out or arrangement of plant that makes for efficient operations and flow of materials, and an equalization of reasonable workloads as determined by competent specialists. Simplicity of operations with little changing of stocks, rovings, and counts of yarn, are also important to any mill that is trying to get maximum production per man-hour.

Adjustments in size of mills and in number of counts spun offer possibilities for reductions in costs. The relationships between size of the mills and manufacturing costs indicate that some carded-yarn manufacturing establishments may be too small for the most efficient operations, particularly in the manufacture of several counts of yarn. The mills generally spin too large a range of yarn counts to permit minimum unit costs of operations. In most mills a reduction in the number of counts spun would simplify the operations and make it possible to more nearly approach the costs indicated for Model mills, which contemplate producing only one count of yarn. With such simplified operations each mill could adopt the machinery, drafts, speeds, and work loads necessary to produce higher degrees of efficiency and lower unit costs. But such simplified operations would necessitate considerable cooperation on the part of persons or organizations responsible for the sales and merchandizing of yarn and of the mill's customers or users of carded yarns.

#### 4.3 An Efficient Wholesale Market

Next consider a group of business units making up the wholesale market for perishables in some city. Is the market as efficient as possible, or could the business be done with less manpower and expense?—Ed.

# 4.3.1 Crow, William C. "Wholesale Markets for Fruits and Vegetables in 40 Cities," U. S. Dept. Agr. Cir. No. 463, Feb., 1938. Pp. 24, 29, 31, 34.

Importance of These Problems. Antiquated, improperly designed and equipped markets, too many markets within a city, inadequate facilities for handling truck receipts, markets without rail connections, unregulated hours, lack of information on supplies, and unethical practices are among the most important problems in the wholesale fruit and vegetable markets of the large cities of the country. The solution of these problems offers one of the most fertile fields for reducing marketing costs with consequent benefits to growers, consumers, and produce dealers. The failure to solve these problems will tend to (1) prevent reduction in the cost of handling fruits and vegetables through the regular (wholesaler-jobber-retailer) channel, (2) encourage further expansion of distribution from growers through largescale retailers (chain stores, voluntary chains, etc.) to consumers with the produce not moving through the regular markets in the large cities, (3) cause produce to move in increasing quantities directly from producers and shippers to smaller cities without going through the large city wholesale markets, and (4) foster the growth of many small markets with duplicating facilities and inadequate supplies.

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How Can These Markets Be Improved? In addition to the more common problems, the markets in each city have peculiarities of their own. Therefore before drawing any satisfactory conclusions for improving the markets of any individual city it is first necessary to make considerable study of local conditions. There is no one panacea for the evils in all markets even though there may be some general principles which need to be considered in all cases. In effecting improvements in the organization, facilities, and practices of the wholesale fruit and vegetable markets of any city three steps are necessary: (1) Research to determine needs, (2) construction or reorganization, and (3) operation.

Construction or Reorganization. After a good plan has been developed for improving the markets in a given city, the next question which arises is that of putting it into effect. Reorganization or construction of markets is a matter which concerns a

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large number of growers, wholesalers, jobbers, and retailers, as well as railroads, trucking companies, banks, property owners, real estate promoters, and industries allied with the distribution of fruits and vegetables. With so many varied interests involved and often a large expenditure of funds required, most individuals regardless of their convictions as to the need for improvements must take the marketing system as they find it. Changes call for group action. Group action is difficult to achieve.

In some cities no new wholesale fruit and vegetable market is necessary, and the problem is one of reorganization to make several existing markets into a unified marketing system. This reorganization is frequently one of the most difficult problems to solve. Even when a plan of reorganization has been worked out, and when a large majority of the interests of the produce industry are agreed upon the plan, it is difficult to get action. Such re organization, if it is to be of any value, will reduce the costs of marketing, and such reductions must of necessity result in a loss of income by certain people or interests. Another reason why reorganization of markets is difficult is that many people prefer high costs each month to the much larger immediate outlay that might be necessary to correct a bad situation. And it should be reemphasized that a large outlay of funds will not necessarily cure a situation and that extreme care should be used in making sure that expenditures for improvements are of real economic value.

Perhaps it is not going too far to suggest that there are a few persons whose interest in increased market efficiency and lower distribution cost is diminished somewhat by the fact that many of these high costs are deducted from the remittance to the shipper or added to the bill of the consumer rather than being paid by the persons actually operating in the markets.

4.3.2 Crow, William C., Calhoun, W. T., and Park, J. W. "Wholesale Fruit and Vegetable Markets of New York City," U. S. Dept. Agr., Bur. of Agr. Econ., April, 1940. Pp. 49, 50, 52-53, 84, 102-3.

It is evident that the present methods of handling fruits and vegetables in New York City would be vastly improved if some way were found by which supplies would be unloaded directly on the floor where they are to be displayed and sold, regardless of their method of transportation. This would result in savings in cartage, deterioration, and time that would run into millions of dollars annually. It would also promote a more general and widespread knowledge of available supplies, which is necessary for proper establishment of prices, and would make easier the marketing tasks of buyers and sellers.

Traffic Congestion. . . . By actual count it was found that throughout most of one night from 1,200 to 1,350 trucks were in this market area at one time. . . . Under these conditions not more than 400 trucks can park at the stores at one time, and they can get there only through heavy traffic congestion. The other hundreds of trucks and wagons must park some distance away and have their loads moved to or from the stores by hand or on hand trucks at a porterage cost of around \$1,340,000 a year. The traffic problem in the market is further complicated by the fact that the market is located in an area through which must pass considerable other traffic that has no connection with the activities of the market itself.

Inadequate Buildings. ... When a buyer visits the store of any particular operator he may purchase supplies that are in the store, on the sidewalk in front of the store, on a truck standing somewhere in the traffic jam, still on the railroad piers, or in a teamtrack yard, or perhaps still on a car float out in the river.

Facilities like these make it impossible for the dealers to develop sound merchandising programs for displaying and selling their products to the best advantage. They make it equally difficut for the buyers to perform their function of assembling supplies for consumers. The chief problems in the market can be summed up in the statement that because of inadequate equipment an unnecessary amount of labor is required. In other words, there is not a proper relationship between physical facilities and labor.

... Such greatly needed improvements in facilities, which the trade must have if it is to operate efficiently, could be provided not only without any increase in rental charges but with an actual reduction in rents over that being paid at the present time, to say nothing of other savings that would be made possible by them.

Improper Location. There is probably no reason why the principal wholesale fruit and vegetable market of New York City is in its present location, except that it was started there more than a hundred years ago when the products of Manhattan's farm lands were brought down to the growing city at the tip of the island.... It is located in a part of New York where the traffic is heaviest and

where movement by motortruck is difficult. Instead of being located near the center of the area that it serves, it is situated at the edge of the city, several miles away from the center of distribution of products moving from it. It is located in the very shadow of the skyscrapers of New York's financial district, where land is of such high value that it would be impossible to get space for expansion at any reasonable cost. . . .

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Price-Making Difficulties. ... In the Lower Manhattan market, supplies are received at many widely scattered places and cannot be concentrated within any one sale area. It is difficult for either sellers or buyers to gain definite information regarding the quantity and quality of perishables available in these several locations. Furthermore, the hours of arrival and delivery of motortruck receipts are unregulated and unpredictable. ...

The Lower Manhattan market is handicapped in its function of price determination by this lack of market information due in large part to the scattering of both supplies and demand. This results in wide variations in price during a single trading period, leading to difficulties and dissatisfaction for shippers, dealers, and buyers.

Lack of Proper Regulation and Management. . . . Perhaps it would be well to note here that there is a distinct element of monopoly in most city markets. This monopolistic feature does not consist, as some people assume, of collusive practices of dealers, for ordinarily there is very substantial competition among the dealers who handle each kind of produce. Owners of the market property, however, have a monopoly over location. This is very important in New York as well as in most other large markets for it is difficult for dealers to do business anywhere except in the established market.

An organized market should be operated under unified management that will take into consideration the interests of the entire industry that does business in it, as well as the general interests of the public... The present primary market in New York City cannot be so operated, for it is made up of many divergent interests with no definite area of jurisdiction. In it, rules and regulations are difficult, if not impossible, to enforce.

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Advantages and Disadvantages of Each Location Summarized. ... A site on the western end of Long Island is near the center of consumption, which represents the shortest average time-distance to buyers. It is accessible to incoming and outgoing truck transportation. It is accessible to incoming rail shipments by means of the usual methods of harbor car-float deliveries, with a possibility of some alternative methods at least in emergencies; for diversions of rail movement, direct connections could be established to the north and east, and the usual car-float interchange would be available to the west and south. In this location a sufficient area probably could be obtained at a reasonable cost.

Summary of Conclusions. In view of the facts and analysis presented in this report, it is recommended that a new, complete, modern wholesale fruit and vegetable market be constructed. Several sites have been discussed in detail, including a New Jersey location and a modernization of the present Lower Manhattan market. After analyzing the advantages and disadvantages of each, it is recommended that the new market be built at the western end of Long Island on some site between the Williamsburg Bridge and the Queensboro Bridge. In this market dealers should be permitted to make sales of any number of packages they wish. Other uses should be found for the present Washington Street market area and the produce piers, so that dealers can dispose of their property in this location on some equitable basis and move into the new market.

The new market should consist of modern store units complete with offices and basements, additional offices for members of the industry who do not operate stores, platform space for unloading, display, and sale of goods not handled through stores, auction sales rooms, team-track yards, streets at least 100 feet wide, parking area for trucks, space for a cold-storage plant, and probably a farmers' market, all enclosed with a fence. The initial construction should be held to the minimum of actual needs, with plans and provisions for expansion when, and if, it is proved to be necessary.

The market should be a union terminal, open to all means of transportation, where supplies can be unloaded directly on the sales floors, thereby reducing cartage to a minimum. The railroad operations in the market should be conducted either by a common operating company representing all rail lines or by some type of organization similar to the private terminals in the harbor area. This operating company would handle switching from float bridges or rail connections to the market, and perform ter-

minal handling operations such as are now performed by the railroads at their own produce piers. This company should receive an allowance from the carriers in payment for the performance of this terminal service, this allowance to cover not only the actual terminal handling operations but also a part of the maintenance and amortization charges for sale platforms. Such charges should be so adjusted that total cost of operations to the railroads would be no more than the present costs, which include maintenance and rent of the produce piers. Rail operations to and from the market should include provision for diversion of carlot shipments on all connecting lines, both to other terminals or warehouses within the city, and to points beyond.

It is believed that a centralized market in this area, if built and regulated along the lines recommended in this report, would make annual savings in distribution costs of about \$8,500,000, after allowance has been made for maintenance of the market and amortization of the investment over a period of 25 years. This estimate is based on the following expected savings on particular items: Cartage within the market, \$2,500,000; porterage within the market, \$600,000; time lost, because of congestion within the market, by trucks moving supplies to and from the market, \$1,200,000; cartage between the market and retail outlets \$800,000; rent on market facilities, \$500,000; pier maintenance and cost of unloading, \$400,000; margins of dealers (primarily in secondary markets), more than \$600,000; and unnecessary deterioration and spoilage, about \$1,900,000.

At the time the survey was made, it was estimated that such a new market could be built at a total cost of about \$14,000,000, including the purchase of a suitable site on Long Island.

The market might be constructed either by a private corporation with public-utility status and properly regulated, or by a public corporation or market authority. Since it is not known that any private corporation is interested in building a market under these conditions, probably the most feasible and practicable approach would be the establishment of a market authority by the city of New York and the States of New York and New Jersey, with some Federal participation representing the interests of people who live outside these two States. This market authority should be governed by a nonpolitical board, empowered to consider proposals made by the trade and others, develop a comprehensive program for market improvement, and put such a program into operation.

#### 4.4 Efficient Assembly and Distribution

Numerous studies have shown the existence of crosshauling, overlapping, and duplication in the assembly and distribution of farm products. Some of it is explainable by differences in the seasonality of supplies, or by differences in quality from one producing area to another. But some of it is doubtless inefficient and distorts the pattern of marketing.

The following two excerpts discuss problems of assembly. -Ed.

4.4.1 Quintus, Paul E. and Robotka, Frank. "Butterfat Procurement by Creameries in Butler County, Iowa," Iowa Agr. Exper. Sta. Res. Bull. 265, Iowa State College, Ames, 1939. Pp. 255-56.

The real problem is to determine what the minimum cost of procurement and processing would be under a reorganization of the trade area. The areas served by individual creameries are characterized by excessive overlapping; the combined area of the trade territories being more than three times the area of the county. Nine creameries were serving the patrons in a single township, as many as five creameries being represented in a single section. One creamery trade area studied served only 14 per cent of the producers within an 8-mile radius.

Not only is the procurement system inefficient, but many of the creameries have too small a volume of business to operate most economically. Maximizing returns to producers involves optimum plant operations, that is, at the point where increased procurement costs would no longer be offset by the economies of a larger volume at the plant. It is probable that fewer and larger plants in the Butler County area, each serving the producers in a minimum area, could save at least 2 cents per pound of butterfat. This would amount to about \$50,000 annually on the basis of Butler County volume.

Two major approaches to the problem are suggested. One is to bring competition among creameries to a sharper focus on the basis of relative efficiency by improving the producers' ability to choose the most advantageous outlet, by increasing the efficiency of manufacturing and of cream route organization and operation and by legislative control of undesirable competitive practices. Control of cream routes and creamery ownership of trucks appears to be essential for the most economical gathering of butterfat by the route method. The second major approach suggested contemplates achieving more quickly and at less cost the readjustment that would be brought about ultimately by present

competitive methods. It is believed much saving would result if the problem of reducing the number of creameries were approached directly by a rationally planned program of readjustment undertaken jointly by producers and the industry.

#### 4.4.2 Hammerberg, D. O., Parker, L. W., and Bressler, R. G., Jr. "Efficiency of Milk Marketing in Connecticut, I. Supply and Price Interrelationships for Fluid Milk Markets," Storrs Agr. Exper. Sta. Bull. 237, Univ. of Conn., Feb., 1942. Pp. 18-20, 31-33.

The Criteria for Milkshed Reorganization. From the foregoing discussion, it may be seen that a number of factors and relationships are basic to the allocation of milk to markets. The most important of these are: (1) the amount of milk required by the several markets and the effects of price changes on these amounts; (2) the location of milk production relative to the markets and the effects of price changes on production; and, (3) the nature of the relationship between distance and transportation costs and the effects of density of production on this relationship. These elements are discussed briefly in the following paragraphs.

The amounts of wholesale milk produced on Connecticut farms and delivered to 14 markets in 1937 have been indicated in Section 2. These amounts have been accepted as representative of the basic requirements for the markets. It is recognized that changes in population and changes in demand would modify these amounts, but the impossibility of making any accurate future estimates of these factors for the several markets led to their exclusion from the present analysis. The elasticity of demand in these markets should be considered, however, since the reallocation of supplies is inherently associated with an adjustment in market prices. Studies of the demand for fluid milk, while subject to important limitations, have invariably indicated that changes of a cent or two in the retail price per quart result in relatively minor changes in the amounts of milk consumed. As will be explained later, the price adjustments involved in the present analysis are quite small, as the maximum change for any market amounted to approximately one-fourth of a cent per quart of milk. Furthermore, these price adjustments would be independent of the general level of prices and concerned only with the differences in the prices in the several markets. The combination of these two circumstances makes it apparent that, for the purposes of the present analysis, it may be assumed that

the market demands would be perfectly inelastic without significantly violating actual conditions.

In Section 3 it was indicated that the density of milk production varied greatly throughout the state. In allocating production to the markets the 1937 pattern of farm sizes and locations has been used to represent the production situation. For the reasons explained above, namely, that price adjustments would be small and that the general level of prices would not be affected, it has been deemed unnecessary to consider any modifications in production that might result from the price adjustments inherent in this analysis. Empirical studies of the response of production to price changes have given widely varying and unstable results, but the general conclusion would seem to be that a relatively large price change is associated with a relatively small change in production.

One of the most obvious shortcomings of the proposed methods of allocating milk to markets would seem to be the discrepancy between airline and road distances. While discrepancies exist and are magnified by such natural barriers as mountains and rivers, there is actually a very close association between these two measures. Investigation has revealed that the correlation between the distance from Connecticut dairy farms to markets by improved roads and the airline distance to those markets is nearly perfect.

Since most wholesale milk would be transported to market by commercial truck routes, the relationship between airline distance and trucking costs is of primary importance. In a companion study of milk transportation, it was found that milk collection could be carried on most efficiently by relatively large trucks and that average collection costs tended to be a linear function of distance. The total distance traveled by a truck route under average density conditions was found to be approximately equal to 20 miles plus 2.5 times the average airline distance from the producers to the market. Efficient collection costs per hundredweight under these conditions could be represented very accurately by 10.2 cents plus 0.4 cents for each airline mile. In other words, the transportation cost-distance relationship under Connecticut conditions and with efficiently organized collection routes may be taken as a linear function with an added cost of 0.4 cents per hundredweight of milk for each additional airline mile from market.

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Production density has a very important effect on collection costs since decreases in density would make it necessary for the trucks to travel greater distances and, therefore, incur higher costs in collecting milk. This has particular significance to a study of milkshed reorganization, as the duplication and overlapping of milksheds would be eliminated, and the effective density of production for each of the markets thereby increased. Basically, the cost modifications involved are functions of the production per mile of collection road, but for convenience in application the relationship has been generalized in terms of production per square mile of area. In terms of production per mile of road and using six-ton trucks, the cost adjustments may be approximately represented by: c =\$0.125/D - \$0.005, where "c" represents the modification in costs per hundredweight or the deviation from the costs indicated by the previously described airline-distance relationship and "D" represents production in hundred pounds per mile of collection road. . . .

Savings from Milkshed Reorganization. The most important result of the reallocation of milksheds along the lines indicated would be the minimization of the costs of assembling milk for all the markets. The cost reduction is the result of two elements: first, the distance factor, since the reorganization of milksheds would minimize the distance from producer to market for all markets taken together; and second, the density factor, as the consolidation of areas and the elimination of milkshed overlapping and duplication would make it possible to assemble milk at a lower cost as a result of the reduction in the distance that must be traveled to pick up or collect a load of milk. For individual markets, of course, the reallocated areas may result in increased costs since present milksheds may be fairly efficient for a particular market but at the same time be responsible for increased costs in adjoining markets.

As is indicated in Table 12, the reallocation of milksheds would result in a saving of more than two cents per hundredweight for the wholesale milk delivered to the 14 markets under consideration. This saving may be divided into a reduction of costs of 0.5 cents as the result of the distance factor and of 1.6 cents as the result of the density factor. In half of the markets the distance factor would actually result in an increase in costs, but the savings in the other markets, especially in Stamford, New Haven, and New London would be large enough to more than offset such increases. The density factor would reduce costs in all markets, although the magnitude of the reduction would vary from less than one to six cents per hundredweight. The combined effect of distance and density would be to reduce costs in all of the major markets except Waterbury. The greatest reduction would be found in the Stamford market, while the largest markets – Hartford, New Haven, and Bridgeport – would have

	Change in Costs That Result From			
Market	Distance Factor	Density Factor	Total	
1. Ansonia.	+0.2	-6.0	-5.8	
2. Bridgeport	+0.1	-1.3	-1.2	
3. Bristol	+0.4	-2.6	-2.2	
4. Hartford	-0.0	-0.9	-0.9	
5. Meriden	+0.5	-4.0	-3.5	
6. Middletown	-1.6	-2.2	-0.6	
7. New Britain	-0.5	-4.0	-4.5	
8. New Haven	-1.4	-1.7	-3.1	
9. New London	-1.4	-2.8	-4.2	
0. Norwich	-0.0	-5.1	-5.1	
1. Stamford	-6.4	-1.7	-8.1	
2. Torrington	+1.6	-2.5	-0.9	
3. Waterbury	+2.1	-1.4	+0.7†	
4. Providence	-0.7	-1.3	-2.0	
All Markets	-0.5	-1.6	-2.1	

TABLE 12 ESTIMATED SAVINGS IN MILK ASSEMBLY COSTS THAT WOULD RESULT FROM MILKSHED REORGANIZATION\* (In Cents per Hundredweight)

\* Does not include any savings that would result from reorganization of truck routes. The indicated savings are the differences between the costs of collecting milk from present areas and from reorganized areas when the collection is performed efficiently in both instances. See EFFICIENCY OF MILK MARKETING IN CON-NECTICUT. 3. Economics of the Assembly of Milk, for details of these computations.

† There would be a net increase in costs for the Waterbury market.

savings of 0.9, 3.1, and 1.2 cents per hundredweight respectively.

In terms of the charges made for transportation and the estimated costs of the efficient transportation from present areas, the savings from area reorganization would amount to from 8 to 11 per cent for the 14 markets considered. There appears to be a definite difference between the major markets and the minor markets with respect to the relative importance of these savings, the per cent reduction over the efficient costs of collections from present areas amounting to an average of approximately nine per cent for the three major markets — Hartford, New Haven, and Bridgeport – and approximately 33 per cent for the three minor markets – Meriden, New Britain, and Ansonia. As the area maps in Section 7 and the data in Table 12 indicate, this difference is largely the result of the density factor, since the milksheds for the smaller markets are almost entirely overlapped by the milksheds of one or more other markets.

Overlapping and duplication are important in distribution as well as in assembly. Several studies have been made of possible savings in milk distribution. The following two excerpts discuss some of the problems which would have to be met in reducing overlapping and duplication whether in assembly or in distribution. Some inefficiencies could be abolished by setting up a private or public monopoly. But, in general, the American public has a strong preference for individual, private, competitive, free enterprise. Theoretically, free enterprise and competition should result in maximum efficiency. Where it does not do so, we search for a compromise. -Ed.

4.4.3 United States Department of Agriculture. "A Survey of Milk Marketing in Milwaukee," Marketing Information Series, DM-1, Agr. Adj. Admin., May, 1937. Pp. 112–13.

The foregoing has set forth the description, estimated capital expenditures, and costs of operation of the proposed unified handling system for Milwaukee. Costs of operation and the like are based upon the assumption that an efficient management could be set up. Depending upon the efficiency of management and the degree of freedom given such management in operating the central system, the foregoing figures may be taken as a fair appraisal of the operations of the system under efficient management.

Certain questions arise as to the feasibility of the proposed system in view of its relationships with producers and consumers. It would appear that unification of distribution facilities would tend to affect producers principally in the disruption of their relationships with distributors. That the effectiveness in bargaining power of producers would be impaired cannot be denied. Their associations undoubtedly would continue to represent them in negotiations with the marketing agency, with prices determined in the customary manner in light of existing supply and demand conditions, modified by local or State regulations, as the case may be. At the same time, the replacement of a number of marketing agencies by one organization would mean that bargaining power probably would be effective only insofar as influenced by competition between buyers for other markets, as for instance, Chicago, and competition for alternative uses. Hence in the absence of regulatory measures, a discriminatory price policy might force a reduction in producers' price temporarily, notwithstanding the differentiation in quality which exists and would exist between milk delivered into the market and that used strictly for manufacturing purposes. Additional support is given to this statement when it is recognized that a large volume of milk over and above fluid requirements would be handled daily by the proposed marketing agency. However, it seems reasonable to assume that an efficient management would be careful not to jeopardize the position of producers.

It would appear that, in the absence of restraint in conduct of management, the interests of consumers under a monopolized system of milk handling could be as easily jeopardized as those of producers. Sound judgment probably would dictate policies fair to the public, but it must be remembered that the bargaining power of consumers is largely nullified when alternative sources of supply are eliminated.

It would follow as a logical presumption that, as far as producers and consumers might be concerned, successful operation of the proposed system would hinge closely upon the degree to which these groups were permitted to participate in the formulation and execution of policy. Public opinion probably does not crystallize with sufficient celerity over short periods of time to warrant dependence upon it as a sole protective device.

#### 4.4.4 Bressler, R. G., Jr. "Efficiency of Milk Marketing in Connecticut, 10. Consumer Demands and Preferences in Milk Delivery," Storrs Agr. Exper. Sta., Bull. 257, Univ. of Conn., April, 1948. Pp. 5, 6, 7, 8, 19, 31-32.

1. Introduction. Four of the preceding reports in this series have dealt with actual and proposed reorganizations in milk delivery methods. These covered such programs as alternate-day delivery, zoned or exclusive delivery territories, and complete public utility or public ownership. Reviewing the findings of these studies very briefly, it is estimated that alternate-day operations reduced delivery truck mileages about 40 per cent throughout Connecticut. Daily deliveries under a system of exclusive territories for each dealer, on the other hand, would permit reductions averaging 74 per cent below the prewar daily delivery mileages, while a combination of alternate-day and exclusive territories would result in over-all savings of some 83 per cent. In general, mileage reductions from alternate-day delivery were slightly higher in rural and suburban areas than in the major

markets, but the potential savings from exclusive territories are greatest in the heavily populated areas. Complete monopoly under a public utility or publicly owned and operated system would give mileage savings comparable with those under exclu-

	<b>D</b> 10 .
Reorganization Program	Cents per Quart †
Present system	
Daily delivery Alternate-day	1.1–1.4
Exclusive territories Small loads:	
Daily delivery Alternate-day	0.6-0.7 1.3-1.6
Large loads I Daily delivery Alternate-day	1.3–1.6 1.9–2.4
Semi-exclusive areas Daily delivery Alternate-day	0.6–0.7 1.2–1.6
Central plant	
Small loads: Daily delivery Alternate-day	2.1-2.4 2.9-3.4
Large 10ads 1 Daily delivery Alternate-day	2.8-3.3 3.4-4.2
Store sales only Unrestricted routes§	1.5-2.0

 TABLE 1

 Estimates of the Cost Reductions That Would Result From Various

 Proposals to Reorganize City Milk Distribution\*

\* For details, see Appendix A.

<sup>†</sup> Using daily delivery as it existed prior to the war as the base from which to measure savings. The range in the estimates results primarily from the use of both prewar and postwar levels of weekly earnings for route men.

<sup>‡</sup> Based on maximum loads of 450 quarts with daily delivery and 600 quarts with alternate-day delivery. Other computations are based on limits of 350 and 450 quarts, but these are being exceeded in many cases at present.

§ Permitting wholesale routes and deliveries to duplicate at will.

sive territories, and in addition would permit a better utilization of plant and delivery equipment.

Estimates of the net effects of such programs on milk delivery costs are given in Table 1. These show the potential cost reductions that would result from the several reorganization schemes if such cost rates as weekly earnings of deliverymen were held constant; they should not be interpreted as estimates of the cost changes experienced by any dealers in past periods. Savings from any program of marketing reorganization may be passed on to the consumer, back to the producer, or be retained by dealers, routemen, and others in the marketing process. Any one or any combination of these may be justified, depending on the particular circumstances.

With these qualifications in mind, the table shows savings from proposed reorganizations ranging from 0.6 to 4.2 cents per quart. Now, if minimum cost were the sole consideration it would be a simple matter to conclude that some form of public utility or public monopoly is the most desirable type of milk delivery. But this is not the case.

The objectives of this study, then, are: (1) to survey consumers in several Connecticut milk markets in order to determine their expressed preferences and demands for marketing services; and (2) to compare these demands with the potential cost reductions in an attempt to give some indication of the desirability of proposed marketing schemes.

Dealer, Connecticut and New York Markets				
	Cumulat	ive Per Cent of Hou	Iouseholds *	
Price Differential Cents per Quart	Connecticut Markets†	Ithaca, New York‡	Jamestown, New York§	
0.0 -0.5 -1.0	38 46 52		3 40 51	
2.0	62	1 50 1	61	

68

100

-3.0.....

-4.0 or more

**TABLE 8** SAVINGS NECESSARY TO INDUCE CONSUMERS TO GIVE UP THEIR CHOICE OF MILK

\* Not including consumers who were uncertain or unable to give specific answers. † Simple average of the two Connecticut surveys.

60

100

‡ Wartime Changes in Milk Distribution and in the Consumption of Milk, Cream,

warting changes in Wilk Distribution and in the Consumption of Wilk, Crean, Butter, and Oleomargarine in Vermont, Thurston, M., Adams, Univ. of Vermont, Agr. Exper. Sta. Bull. 527, Burlington, Vermont (Oct., 1945).
 § "Consumers' Attitudes Toward Unified Delivery of Milk and the Proposal for a Municipal Milk Plant in Jamestown, New York," Leland Spencer and H. Alan Luke, New York State Coll. of Agr., Mimeograph A. E. 404 (Sept., 1942).

|| Including those who were unwilling to accept the proposal regardless of savings.

75

100

Conclusions. From the foregoing material, it is apparent that most Connecticut consumers would be interested in programs to reorganize milk distribution with the intent of lowering milk prices. The vast majority of householders interviewed are not willing to pay higher milk prices in order to have their milk delivered every day. About two-thirds of the families would be willing to accept a program involving exclusive delivery territories if consumer savings amounted to 1.9 to 2.4 cents per quart, and slightly more than half would favor some form of municipal distribution with savings ranging from 3.4 to 4.2 cents per quart. While considerable amounts of milk are sold through stores in Connecticut markets, much of this supplements regular home delivery and less than one quarter of the consumers surveyed indicated a willingness to give up home delivery completely in order to save 2.0 cents or less per quart.

While these proportions have been based on careful estimates of the potential savings that would result from milk distribution reorganization, there is no assurance that savings of this magnitude would be passed on to consumers. Certainly producers and middlemen would want to retain some of the savings in the form of higher producer milk prices, higher wages, and wider margins. As a result, it may be argued that these estimates are too optimistic, even though it is admitted that most of the savings would normally be passed on to consumers through lower prices over a long-run period.

On the other hand, there is evidence that consumers as a group are overconservative in forecasting their reactions to new and changed conditions. This was illustrated by the reported reluctance of consumers in Ithaca, New York, to consider alternate-day delivery in 1940 and the almost universal satisfaction with the program that characterizes consumer reactions in markets where the program has been in effect for some time.

Aside from the reaction to any specific proposal for reorganization, the survey results suggest that most consumers are favorably disposed towards milk marketing reorganization. It is frequently implied that consumers are perfectly content with the existing system of distribution. The results reported in this bulletin give very little support to this contention or little cause for satisfaction on the part of those who have advanced it. Excluding the alternate-day delivery program that already is in effect, more than 40 per cent of Connecticut consumers appear willing to have some fairly drastic form of milk delivery reorganization without any promise of price reductions while 60 per cent would be interested with savings of one cent or less (Table 13). In contrast, only 22 per cent are so satisfied with the present system or so distrustful of new proposals that they would be either completely unwilling to change or would require price reductions of five cents or more per quart. Such factors as brand names and personal relationships with handlers are important, in this field as in others, but not so important as to prevent most consumers from giving favorable consideration to new forms of milk distribution.

It must be admitted quite frankly that there is no way to evaluate objectively all of the pros and cons of marketing reorganization except through actual experience. The present

 
 TABLE 13

 Effect of Potential Savings on the Willingness of Connecticut Consumers to Consider Some Form of Reorganization of the Milk Industry

Potential Savings Cents per Quart Cum	
0	42
1.0	60
2.0	69
3.0	74
4.0	77
5.0 or more	99
Uncertain	100

\* Simple average of Connecticut surveys. This combines consumer replies on exclusive delivery territories, municipal distribution, and the elimination of home delivery, tabulating the lowest savings required to induce the customer to accept any of the three proposals.

study and those that have preceded it in this series have attempted to provide information as specific as possible on certain aspects of the problem — aspects that more often have been the subject of speculation than of real knowledge. Other aspects are unanswered and some will remain so until actual experience is available to serve as a guide. The present findings are promising enough, certainly, to encourage experimentation in selected markets.

#### 4.5 Efficiency of the Marketing System

The concept of efficiency is fairly clear when studying detailed processes such as that of putting celery into a crate. But macro-efficiency is a difficult concept. What do we mean by the efficiency of the whole marketing system? What standards have we for measuring it?

The plain fact is that the concept of macro-efficiency is rather vague and cannot be measured accurately by statistics. The economist cannot determine the "optimum use of resources" in any absolute sense. Nor can he devise a marketing structure which will at the same time reach such conflicting goals as maximum farm income, minimum cost to the consumer, and minimum expense for transportation and marketing. This does not excuse the economist from his duty to seek improvements in efficiency. It means only that this is a job requiring a great deal of judgment. In the final analysis, the citizens determine what use of resources they think is best. The economist can supply information, and can help the public understand the probable results of alternative actions.

The following three readings illustrate some approaches to this problem.—Ed.

#### 4.5.1 Hoffman, A. C. and Waugh, F. V. "Reducing the Costs of Food Distribution," Farmers in a Changing World, Yearbook of Agriculture – 1940. U. S. Dept. Agr., Washington, D.C., 1941. Pp. 630–32.

Marketing Efficiency and Increase in Marketing Services. The charge most commonly made against the marketing system is that it is inefficient and becoming more so. The increase in absolute marketing spreads, together with the fact that the farmer's share of the consumer's dollar has tended to decrease, is often cited as evidence of this. Taken by themselves, however, neither of these things gives any direct measure of efficiency as that term is properly used.

If the farmer were to process his own products, transport them to market, and sell them direct to the consumer, there would of course be no margin between him and the consumer and he would get 100 per cent of the latter's dollar. Obviously this would not be an efficient way to market most farm products, and for some of them it would be patently impossible. The proportion of the consumer's dollar received by the farmer, then, is not a measure of efficiency but rather of the degree to which farmers concentrate on the business of production rather than on marketing. Some farm products — for example, eggs that are produced near the point of consumption — do not require expensive processing or transportation. The farmer selling such products will normally receive a much larger share of the consumer's dollar than one producing peas for canning, for instance, even though both products are marketed with equal efficiency.

It is generally agreed that consumers receive more in the way of marketing services today than they once did. Examples of this are better grading and standardization, more convenient packages, and added processing. It is impossible even to estimate how much has thus been added to marketing costs. But so long as these things add to consumer satisfaction, it is self-evident that any resulting increase in the spread between farmer and consumer does not mean that the marketing system has to that extent become less efficient.

From the social standpoint, efficiency ought to be measured in terms of the amount of labor and capital required for the performance of any given marketing operation. The amount of labor required should be clearly distinguished from the wage rate or the compensation paid to labor for its services. Thus the marketing spread might increase either because more labor and capital are used for a given operation or because labor and capital are better paid. The first would be evidence of growing inefficiency but not the second. As we have seen, the increase in marketing spreads during the last 25 years is to be explained largely by the increase in hourly wage rates. But it does not follow that the marketing system is less efficient in terms of the amount of productive resources used per unit of marketing services rendered.

As a matter of fact, there is some evidence to indicate that food distribution is becoming more, rather than less, efficient. One thing which points in this direction is that food margins have not increased in proportion to the increase in hourly wage rates despite the fact that consumers are receiving as much in the way of marketing service as they ever did.

Still another thing should be kept in mind when considering marketing efficiency – the distinction between those marketing costs or expenditures made for the purpose of satisfying demand and those made for the purpose of influencing it in favor of a particular firm's product. Most costs incurred in connection with the physical handling of the commodity such as assembling, processing, transporting, and storing are of the former sort. So also are part of those for selling and transferring ownership of commodities at various stages in the marketing process. But it is also true that many – though not all – of the expenditures for salesmen's salaries, brokerage fees, and brand advertising are made for the purpose of influencing the buyer to patronize a particular firm or to use a particular brand or type of commodity. Insofar as expenditures of this kind contribute to the creation of new wants, larger total sales, and reduced produc-

tion costs, they serve a socially necessary and useful purpose. But if the effect is merely to take business from one firm and give it to another, then clearly there is no net social gain but only a transfer of advantage between individual firms. We should, therefore, take care to distinguish between the over-all efficiency of the marketing system and that of individual firms, since the two are not necessarily synonymous.

4.5.2 Bressler, R. G., Jr. "Efficiency in the Production of Marketing Services," *Economic Efficiency Series*, Paper No. 6, Social Science Res. Council Proj. in Agr. Econ., Univ. of Chicago, Summer, 1950. Pp. 3-4.

No attempt is made to identify efficiency as defined with the concept of general welfare, although the writer has personal convictions that (1) efficiency has an important bearing on general welfare, and (2) improved efficiency will usually be consistent with generally accepted welfare goals. It can be demonstrated that an increase in efficiency will mean an increase in the total output of goods and services from given resources, and so would permit an increase in real income. This means that it would be *possible* for everyone to have more of every economic good (leisure included), and thus strongly suggests that efficiency will be in line with welfare. Where achieving efficiency would require marked changes in social and economic institutions or would impose on values outside the market mechanism, however, society may well choose less efficient organizations. If maximum efficiency requires strict control over many economic activities or the socialization of certain sectors of the economy, for example, we may choose more freedom and less efficiency. To repeat, efficiency is only one aspect of general welfare and cannot be used to define a unique set of goals and policies for society.

It may be worth stressing that the possibilities for discrepancies between efficiency and welfare increase as we consider higher and higher levels of economic organization. Thus there appear to be only limited departures between individual and social objectives in achieving efficiency within a particular plant. The combination of plant and transportation functions involve greater disturbances to institutional arrangements and more interpersonal comparisons, while the efficient organization or reorganization of an industry may bring the conflict between efficiency and social welfare into sharp focus. Changes in the allocation of resources among major sectors of the economy further multiply these difficulties. In view of this, we present the concept of efficiency as only one – albeit an important – consideration in social welfare. When presented to society, the descriptions of alternative organizations in terms of their efficiencies and the social and economic changes required to achieve efficiency will not *define* the social choice but will permit the choice to be made in an informed and intelligent manner. This also defines our concept of the role of the research economist — to select areas where he believes society is interested in efficiency and to describe possible alternatives so that society will have a better basis on which to make decisions.

#### 4.5.3 "Input-Output Relationships in Agricultural Marketing," Marketing Margins and Efficiency, Report of Marketing Research Workshop, July 9-19, 1950, Purdue Univ. U. S. Dept. Agr., Agr. Res. Admin. Pp. 183-84, 185-87, 188-89.

The Problem Area: Operational Efficiency in Agricultural Marketing. The marketing system for farm products serves two broad purposes: (1) through assembly, processing, transporting, storing, distributing, and similar operations, to add form, time, and place utilities to the raw farm products in moving them from farm to consumer; (2) through the various mechanisms of exchange, to allocate these commodities among buyers, and the returns for them among sellers, and thereby to give expression to consumer preferences as guides to the use of productive resources in both primary production and marketing itself. The "efficiency" of the marketing system – and of it segments – must ultimately be evaluated in terms of effectiveness with which these purposes are served: the relationship between the consumption utility created and the resources used in its creation.

\* \* \*

This Workshop is concerned directly with the first of the two broad purposes of agricultural marketing — with the problem of operational efficiency (as distinct from pricing efficiency) and the study of costs and margins as they bear upon this problem. This essentially technological phase of the problem can in principle be isolated for separate study. We can inquire, given the existing structure of prices and price-making mechanisms, what is the efficiency of the marketing system, or of segments of it, in terms of the form, time, and place utility created in relation to resource input; and how can this efficiency be increased? We must recognize, however, the limitations of the answers arrived at in such a restricted study: That "improvements" in operational efficiency cannot be finally evaluated without consideration of their effects upon pricing efficiency; and that changes in price-making may invalidate the findings of an operational efficiency study, since they alter the assumptions that underlie it.

The central difficulty of definition and measurement in this problem turns upon the concept of consumption utility as the ultimate criterion of output. We have no direct measures of consumption utility. However, if we can assume "that the unmeasurable utility produced is correlated with some measurable quantity," we may have at least a basis for comparing the efficiencies of different operations. One such quantity suggested by Black and Houston is the "value added by marketing" as measured by "the difference between the prices received by the primary producers and the prices paid by the final consumers," or, more generally, by the price margin covering the operations analyzed. Conceptually, of course, such a measure begs questions as to the validity of the prices as reflectors of consumer choices, and hence is subject to the shortcomings previously referred to, inherent in the attempt to isolate operational from pricing efficiency.

On the input side, individual resources used in the operation can in many instances be measured directly in physical terms: e.g. labor in man-hours. Where the use of capital equipment is involved, charges can be assigned for depreciation and interest. In this way a set of "partial indexes of efficiency" can be built up, in terms, e.g., of "output per man-hour of labor" or per unit of other resource.

Some partial indexes can be compared as between two operations, e.g., the marketing of meat and of milk, and this comparison may be revealing in a number of ways. If the partial indexes for all resources turn out to be higher for one operation than for another, it would appear valid to conclude that the one operation is the more efficient. Where the comparisons lack such fortunate unanimity, they may still be suggestive of problems needing exploration: Why, for example, is output per man-hour greater or smaller in meat marketing than in milk marketing? No definitive conclusions as to over-all efficiency can be drawn in such cases, however, since the explanation may lie in justifiable differences in the structure of inputs. Such comparisons have greatest validity where the structure of inputs is similar in the two markets.

What is needed for over-all comparisons is obviously an aggre-

gative measure of inputs - an index combining man-hours of labor, services of capital assets, and quantities of other resources used. The attempt to apply price weights in constructing such an index, however, causes the whole analysis to break down. For aggregate input then comes to consist of the cost expenditures going to make up the margin that has been used as the measure of output. If all expenditures are included, input becomes identical with output and all operations appear to have 100 per cent efficiency. Certain expenditures may be omitted as not corresponding to "real" resource inputs: for example, profits in excess of some "normal" entrepreneurial return. But then "efficiency" turns out to have been measured by the size of this omission from the denominator of the output-input fraction: The more efficient operation is that with the relatively larger "abnormal" profits, reflecting imperfections and rigidities in the market. Here again the difficulty of isolating operational from pricing efficiency intrudes itself to vitiate our attempts at measurement.

Single commodity comparisons. The cause of this unhappy result is, of course, our lack of independent measures of aggregate input and output. It may be gotten around if methods can be devised for measuring either input or output independently of the pricing system.

One situation in which this appears possible is in comparison between similar operations with a single commodity: e.g., in comparing the efficiency of milk marketing in two different cities. Here if we are willing to make the bold assumption that a unit of the commodity has the same average utility in both markets, the total volume of the commodity marketed may be taken as a measure of output. Calculating the index of aggregate input as described above, we can obtain comparative estimates of efficiency in terms of, e.g., quarts of milk per dollar's worth of resource input.

This device avoids the methodological impasse described above, arising from the identity of the measures of inputs and outputs. It does not avoid the problem of the validity of prices, since the index of inputs is price-weighted. For inter-market comparisons the same weights must, of course, be used in both markets, and some basis is required for the selection of these weights. This selection should be specific to the question asked. If, for example, city A wishes to determine whether it would gain in operational efficiency by adopting the milk marketing system of city B, the analysis should use as weights the prices of factors

that prevail in A. Or, at the risk of confusing questions of operational as versus pricing efficiency, arbitrary price weights may be assigned that are assumed to represent a "truer" evaluation of inputs than prices actually prevailing in the "problem" market.

Comparisons may similarly be made of a single marketing system at different times. Here, again, weighting should be by prices prevailing, or assumed appropriate for evaluating resources, in the time period on which the primary attention is focused. Is milk marketing in city A today, in terms of the present valuation of inputs, more efficient than it was 5 years ago? In comparisons over time, of course, changes in quality of the commodity, in the services associated with its distribution, or in consumer tastes themselves may invalidate physical volume as the standardized measure of output. Such comparisons are most valid for short-time periods in which there have been no radical changes in treatment of the commodity. In spite of these limitations, the development of time series showing trends in efficiency for a number of commodities should provide highly suggestive data.

Comparisons may likewise be made of an actual system with a hypothetical system designed for maximum operational efficiency. Here again it must be kept in mind that analysis in terms of *operational efficiency* rules out of consideration the effects of price changes that might result from a proposed change in operation, or even that might be used as a means of inducing such a change. Substituting capital for labor, for example, may cause compensating adjustments in wage rates relative to charges for capital inputs.

Summary and Conclusions. The possibility has been explored of adapting input-output analysis for measuring the operational efficiencies of whole marketing systems or segments of them. The method faces a basic conceptual difficulty in devising measures of consumption utility as the criterion of output. Price margins may provide a practical, rough measure. Combination of this measure with physical inputs of individual resources permits the calculating of partial indexes of efficiency that may have suggestive value in indicating problems worth further investigation. Combination of it with a price-weighted index of total input of all resources breaks down, however, because the measures of output and input are no longer independent.

This problem may be overcome in comparing the efficiency

3

of similar marketing operations for a single commodity by using physical volume of the commodity as the measure of output. The method may be extended to a group of commodities with a common raw material by constructing a price-weighted index of combined output. For example, we may compare the efficiency of different markets for fluid milk, and may take account of differences, e.g., in the service rendered in home delivery versus store sale.

Uses and limitations of the method. Such a measure of comparative operational efficiency should be useful:

- 1. For indicating "problem" markets, where existing inefficiency suggests the desirability of concentrating remedial efforts.
- 2. For suggesting (by the "partial indexes") the factors being used inefficiently, and hence the possible direction of needed adjustments.
- 3. For indicating changes in efficiency in a single market over time, and especially for testing the results of actions undertaken to increase efficiency.
- 4. For comparing actual with hypothetical or synthetic marketing systems.

In making the applications listed above, the following limitations should be borne in mind:

- 1. The measure is rough, at best, because of the difficulty of precise measurement either of consumption utility or of input aggregates.
- 2. It helps only to locate the problem area; it does not solve the problem.
- 3. Comparisons must be qualified in the light of inherent differences between the markets, e.g., in market density, that may make differences in efficiency as here measured unavoidable.
- 4. The conclusions derivable refer only to operational, as distinguished from pricing, efficiency, and they assume the need for price-weighting as an invariable condition of a problem.