Trends in Labor Input and Output in Selected Agricultural Processing Industries, 1947–57

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Valid measures of the changing output of the marketing system in comparison with the inputs of resources such as labor are of basic importance in appraising the efficiency of the marketing system, in determining those segments of the system where possibilities for improvement are marked, and in examining a wide variety of other economic questions. Attempts to improve measures of input-output relationships have been beset by numerous difficulties relating to the quality of output, the fact that some output is in the form of service attached to a product rather than a physical commodity, the problems of disassociating inputs of different types of factors, and other questions regarding the nature of inputs. This article reports various methods that can be employed in the measurement of output per unit of labor and suggests the difference or bias that can result when various concepts are used. The methods employed produce findings that give a picture of trends in output per unit of labor input. As further Departmental studies yield improved measures of these relationships, they will be reported.

ONE ASPECT of appraising the efficiency of marketing involves measurements and analysis of movements in output per worker. Current measurements of marketing efficiency published by the Department deal with labor cost per unit of product and with the relationships between cost and price changes for certain other goods and services used by marketing firms. Although the Department has published a continuing series dealing with farm productivity, no such series exists for marketing farm food products.

This article represents an attempt to measure labor efficiency in real terms—output per person and per man-hour—for a few segments of agricultural marketing for which there are sufficient data to permit such estimates. While the data used pertaining to production and to labor inputs have some shortcomings, as will be discussed, the measures of output per unit of input here reported appear to provide good indicators of the general trends during the last decade.

In general, gains in efficiency are reflected in increases in output relative to input. Measures may be developed to determine changes in output in relation to the total of inputs of all factors or to the input of individual factors. While measurements of this kind indicate the change in efficiency of resource use over time, they do not indicate optimum patterns of resource use. Nevertheless, such measures provide a workable basis for determining trends in efficiency. As such, they are useful tools in measuring changes in a given industry over a period of time, and, at least, among those industries in which the pricing system is operating without serious imperfections, they afford a method of comparing changes in efficiency among different industry groups.

The purpose of this study is to examine the extent to which changes in output have been related to changes in one factor—labor input. Six major agricultural processing industries—baking products, dairy products, meat products, canned and frozen foods, sugar, and grain mill products—have been selected for examination. These industries represent a substantial part of agricultural marketing activity, including about a million employees and accounting for approximately $34 billion in value of shipments in 1954. The period covered is 1947 through 1957.

Four Different Indexes Suggested as a Measure of Labor Productivity

For the purpose of measuring output in relation to labor input in selected agricultural processing industries, four different indexes were constructed and are presented in this article. First, an index of output per production worker was constructed (table 1). To incorporate the concept of man-hours of labor and to reflect changes in number of hours worked per week during the period 1947–57, a second index, that of output per production worker man-hour was computed

TABLE 1.—*Index of output per production worker, selected processing industries, 1947–57*

[1947–49=100]

Year	Output per production worker in processing—					
	Bakery products	Dairy products	Meat products	Canned and frozen foods	Sugar	Grain mill products
1947	99	100	103	95	96	99
1948	99	98	100	98	95	98
1949	102	102	97	107	109	102
1950	104	108	100	115	115	106
1951	105	109	101	122	106	109
1952	105	117	101	122	115	111
1953	105	129	101	120	122	116
1954	105	134	104	118	128	115
1955	106	141	112	124	132	116
1956	108	150	111	136	143	116
1957	111	157	111	138	143	121

TABLE 2.—*Index of output per production worker man-hour, selected processing industries, 1947–57*

[1947–49=100]

Year	Output per production worker man-hour in processing—					
	Bakery products	Dairy products	Meat products	Canned and frozen foods	Sugar	Grain mill products
1947	98	99	100	93	94	97
1948	98	98	99	100	97	99
1949	103	104	100	107	110	104
1950	105	110	103	114	113	109
1951	106	112	104	119	110	108
1952	106	121	104	121	117	110
1953	106	133	106	120	120	118
1954	108	141	108	119	126	116
1955	109	146	114	124	129	117
1956	111	159	115	133	140	120
1957	116	168	117	138	141	125

(table 2). A third index which reflected changes in output per worker was constructed. In addition to production workers, it included all sales, clerical, technical, administrative, and professional workers (table 3). Finally, an index was computed on the basis of estimated man-hours worked by all employees (table 4).

Each of the indexes can be used to show a relationship between labor inputs and output, and each has the merit of showing more than the Federal Reserve Board index of production in that it relates output to labor input. Total inputs consist of inputs of land and capital in addition to labor, but only labor inputs are considered in this article.

Each of the indexes incorporates a different concept with respect to input. For example, output is shown in relation to number of production workers as contrasted to number of production-worker man-hours. If the number of production

TABLE 3.—*Index of output per employee, selected processing industries, 1947–57*

[1947–49=100]

Year	Output per employee in processing—					
	Bakery products	Dairy products	Meat products	Canned and frozen foods	Sugar	Grain mill products
1947	101	102	104	96	97	100
1948	99	98	99	98	95	98
1949	100	100	97	106	108	102
1950	100	103	99	114	114	102
1951	98	100	100	122	102	103
1952	97	106	100	120	110	105
1953	96	116	100	119	117	106
1954	93	118	102	117	122	106
1955	93	124	110	122	126	104
1956	93	132	110	133	137	103
1957	95	138	109	134	136	105

TABLE 4.—*Index of output per employee man-hour, selected processing industries, 1947–57*

[1947–49=100]

Year	Output per employee man-hour					
	Bakery products	Dairy products	Meat products	Canned and frozen foods	Sugar	Grain mill products
1947	100	102	102	94	95	98
1948	100	98	98	100	97	99
1949	97	101	99	106	108	103
1950	102	105	101	113	113	104
1951	99	103	102	119	105	103
1952	98	110	103	119	112	105
1953	97	119	104	119	115	108
1954	95	123	105	117	122	107
1955	94	129	111	122	124	106
1956	95	139	113	132	136	106
1957	98	146	114	133	135	109

workers did not change but the number of hours worked by these employees changed, the second index would show this concept, whereas the first would not.

When the number of other-than-production workers changes in relation to production workers, as has been the experience during the period studied, increases in output in relation to total number of employees is smaller than for production workers only.

Output in Selected Processing Industries and in Agriculture

Except for bakery products, output has increased in relation to input measured on all four bases. In bakery products, output per employee and per employee man-hour decreased during the period studied. Table 5 shows output per man-hour in United States agriculture from 1947 to 1957. It can be compared with table 2, which

TABLE 5.—*Index of output per man-hour, United States Agriculture, 1947–57*

(1947–49=100)

Year	Output per man-hour
1947	92
1948	104
1949	104
1950	112
1951	113
1952	120
1953	123
1954	127
1955	132
1956	136
1957	143

Agricultural Research Service.

shows output per production worker man-hour in selected processing industries and table 4, which shows output per employee man-hour in the same industries.

Yearly Changes in Output

Tables 6, 7, 8, and 9 show, for each of the labor-input measures, the estimated yearly percentage changes, and they suggest the differences in the output that may be shown by each of the different measures. The estimated average annual rate of change for the private non-agricultural sector of the economy is 2.2, 3 percent for all manufacturing, 2.5 percent for mining, and 2 percent for farming.[1]

Methodology and Limitations of Measurements

The measure of output of the selected food-processing industries used for this article is the Federal Reserve Board's index of industrial production. This index is a measure of the changes in the country's physical output at factories. The index measures physical volume, not value of the output of an industry. In addition, the index does not reflect changes that affect the quality of products, including additional services produced by food manufacturers, nor does it separate secondary products produced by plants primarily classified into the industry described. The production index measures a physical output that is not constant over time in either quality or composition.

The number of production workers and the total number of employees in each of the industries studied are those reported by the Bureau of Labor Statistics. The index of output per production worker was obtained by dividing the index of output by an index of production workers; similarly, the index of output per employee was obtained by dividing the index of output by an index of the total number of employees in the industries specified. To obtain the index of output per man-hour, an index of man-hours was computed using the yearly average number of hours worked weekly by production workers as reported by the Bureau of Labor Statistics and assuming a 52-week year. For technical, clerical, sales and administrative employees, an assumption was made of a 40-hour week and a 52-week year.

Summary and Conclusions

Four possible measures of labor productivity can be computed from data published by the Federal Reserve Board and the Bureau of Labor Statistics: (1) Output per production worker; (2) output per production worker man-hour; (3) output per employee; and (4) output per employee man-hour.

Although the measures presented here offer no explanation for the fact that output as measured in any of these ways has changed, they do show the direction and the magnitude of changes in output relative to labor inputs. One weakness of using output as an indicator of productivity change is that when proportions of the different factors have varied, changes in the ratio of output to one input may reflect substitution of factors as well as changes in overall productive efficiency. Only by relating output to all inputs can it be determined whether there has been a net saving in real costs per unit of output, or, conversely, a gain in productivity.[2]

The factor considered to be most important in increasing output per employee is greater and more efficient capital per worker. Nevertheless,

[1] Joint Economic Committee. PRODUCTIVITY PRICES AND INCOMES.

[2] Kendrick, John W. PRODUCTIVITY TRENDS: CAPITAL AND LABOR. *Rev. of Econ. and Statis.* August 1956, p. 248.

TABLE 6.—*Yearly percentage changes in output per production worker, selected processing industries, 1948–57*

[1947–49=100]

Year	Bakery products	Dairy products	Meat products	Canned and frozen foods	Sugar	Grain mill products
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1948	0	−2	−3	3	−1	−1
1949	3	4	−3	9	11	4
1950	2	6	3	7	6	4
1951	1	1	1	6	−8	3
1952	0	7	0	0	8	2
1953	0	10	0	−2	6	4
1954	0	4	3	−2	5	−1
1955	1	5	8	5	3	1
1956	2	6	1	10	8	0
1957	3	10	0	1	0	4

TABLE 7.—*Yearly percentage changes in output per production worker man-hour, selected processing industries, 1947–57*

[1948–49=100]

Year	Bakery products	Dairy products	Meat products	Canned and frozen foods	Sugar	Grain mill products
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1948	0	−1	−1	8	3	2
1949	5	6	1	7	13	5
1950	2	6	3	7	3	5
1951	1	2	1	4	−3	−1
1952	0	8	0	2	6	2
1953	0	10	2	−1	2	7
1954	2	6	2	−1	5	−2
1955	1	3	6	4	2	1
1956	2	9	1	7	8	2
1957	4	6	2	4	1	4

changes in the ratio of output to total inputs show the joint effect of many separate, though interrelated influences like technical improvements, such as improvements in plant layout, work flow and material-handling procedures; the relative contributions to production of plants at different levels of efficiency; changes in volume of production; the skill, effort and incentive of the labor force; and the efficiency of management.

Gains in output in relation to input make it possible to lower costs of production, which can result in business expansion, lower prices, higher wages or increased profits, or combinations of these results.

The measures presented here permit comparisons between processing industries and show, by comparisons between the index of output per production worker and the index of output per employee, the increasing significance of the increase in number of other-than-production workers. The comparisons between industries indicate the food-processing industries which appear to operate with greatest efficiency, as contrasted with those industries which appear to be lagging. Also, it may be observed that there appears to be an inverse relationship between output per unit of labor input over the past 10 years as reported in this article and the extent to which marketing margins for selected products in these industries have increased. That is, increases in margins appear to have been lowest in those industries where labor efficiency has increased most and highest in those industries where labor efficiency has shown little change.

TABLE 8.—*Yearly percentage changes in output per employee, selected processing industries, 1947–57*

[1948–49=100]

Year	Bakery products	Dairy products	Meat products	Canned and frozen foods	Sugar	Grain mill products
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1948	−2	−4	−5	2	−2	−2
1949	1	2	−2	8	11	4
1950	0	3	2	8	6	0
1951	−2	−3	−1	7	−10	1
1952	−1	6	0	−2	8	2
1953	−1	9	0	1	6	1
1954	−3	2	2	−2	4	0
1955	0	5	8	4	3	−2
1956	0	6	0	9	9	−1
1957	2	4	1	1	1	2

TABLE 9.—*Yearly percentage changes in output per employee man-hour, selected processing industries, 1947–57*

[1948–49=100]

Year	Bakery products	Dairy products	Meat products	Canned and frozen foods	Sugar	Grain mill products
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1948	0	−4	−4	6	2	1
1949	−3	3	1	6	12	4
1950	5	4	2	7	5	1
1951	−3	−2	1	5	−5	−1
1952	−1	7	1	0	7	2
1953	−1	8	1	0	3	3
1954	−2	3	1	−2	6	−1
1955	−1	5	6	4	2	−1
1956	1	8	2	8	10	0
1957	3	10	1	1	−1	3

AMS Reports Win American Farm Economic Association Awards

The American Farm Economic Association at its recent annual meeting cited two reports published by the United States Department of Agriculture during the past year—Agriculture Handbook No. 141, "Distributed Lags and Demand Analysis for Agricultural and Other Commodities" by Marc Nerlove, and "Carryover Levels for Grains" by R. L. Gustafson. The handbook was one of three awards for the best published research, and the technical bulletin one of the three best doctoral theses. Both reports were issued by the Agricultural Economics Division, Agricultural Marketing Service.