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Minnesota Farm Business Notes

Returns to Poultry Research in the United States

W. L. Peterson

The aims of this study were:

1. To identify efficiency gains in the production of poultry products (eggs, broilers, and turkeys) due to new inputs created by poultry research.
2. To obtain a measure of the return to investment in such research.

Poultry research by state agricultural experiment stations, the U.S. Department of Agriculture (USDA), and suppliers of poultry inputs (primarily hatcheries, drug companies, and feed manufacturers) is viewed here as a production activity. The inputs consist of such things as man-hours of research effort and laboratory facilities; the output consists of new knowledge. This new knowledge then results in the development of new inputs (new drugs, new rations, improved management practices, etc.) In turn, these inputs increase efficiency when they are adopted by farmers.

Thus, the line of causation runs from research to new knowledge to new inputs to increased efficiency. Therefore, the returns to poultry research consist of a "saving in resources" that results from more efficient production of poultry products. These returns are social returns that our society obtains because resources are devoted to poultry research.

SOURCES OF POULTRY PRODUCTIVITY GAINS

For this study, we considered the major sources of productivity gains and then attempted to identify and measure gains only from poultry research.

Major Sources

The major sources of productivity gains in poultry production include:

1. Improved genetic quality of birds due to breeding research.
2. Improved rations resulting from a better mix of ingredients and addition of new ingredients known as feed additives.
3. Improved structures and equipment because of improved building materials, ventilation, lighting, etc.
4. Improved labor and management because of an increase in the general educational level of farmers and new management techniques.
5. Shifts in production areas which reduce the cost of transporting poultry products to market and, sometimes, housing costs.
6. Economies of scale and specialization obtained by the shift towards large, highly specialized poultry farms.
7. Reduced input prices, over what they would be, because of productivity gains obtained by farm suppliers.

Sources Specific to Poultry Research

We are reasonably certain that improvements in the quality of chicks and poults as well as rations are the products of poultry research. Whether improvements in poultry structures and equipment are solely the results of poultry research is less certain. Nevertheless, poultry research probably has had some part in the observed improvements, especially in equipment.

Skills arising from increased schooling would not be products of research. But improved management techniques such as more adequate control of disease and better culling and feeding practices are research products.

ALTERNATIVE RATES OF RETURN TO INVESTMENT IN RESEARCH

Generally, poultry research has had its most pronounced effect on the quality of birds, feed, and management. But how can the return to poultry research be measured?

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Turkey Production and Consumption in the United States

C. G. Swenson and W. L. Peterson

The U.S. turkey industry developed rapidly during the last 35 years. Production increased from 178 million pounds in 1930 to 1,508 million pounds in 1965 (see the table, page 3). On the average, production nearly doubled every 10 years.

Per capita consumption of turkey also increased from 1930 to 1965 but at a slower rate than total production because of population increases. Although turkey meat still represents a small part of total meat consumption, the proportion increased steadily from 1.1 percent in 1930 to 3.6 percent in 1965.

Turkey meat is one of the few products that sells for about the same price today as it did 35 years ago. When the price of turkey is adjusted for the rise in the general price level, its "real" or deflated price is actually lower today than it was in the early 1930's. The principal reason for this situation is the productive efficiency achieved by farmers. Farmers have reduced the cost of production and, thereby, have reduced the market price; competition forces price down toward production cost.

Seasonal Characteristics

An important characteristic of the turkey industry is the seasonal consumption and production of the product.

Turkey is used mainly for the Thanksgiving and Christmas holidays. In the 1930's, about 75 percent of the turkeys raised were consumed during the holiday season; today this figure is about 55 percent. Consumption is relatively low early in the year, increases to a peak in November, and then decreases in December (see the figure, page 3).

The production of turkey exhibits about the same seasonal characteristics as consumption, due in part to improved conditions for producing hatching eggs and poults in spring. In addition, the linking of production with consumption reduces the need to build up large storage stocks of turkey during periods of relatively low consumption.

Consumer Response to Price Changes

An important question facing turkey producers and marketing agencies is:

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Poultry Research . . .

(Continued from page 1)

Our first task was to select a measure that would pick up the productivity gains identifiable with poultry research. Although no one measure is likely to accomplish this task perfectly, alternative measures will provide a reasonable lower bound to the benefits of poultry research. Gains in feed efficiency (output per feed unit) is such a measure.

Feed Efficiency

Since about 1930, poultry output per feed unit has trended upward (see table 1). The feed unit equaling 1 pound of corn in feed value is a convenient measure to use for two reasons:

- It is not influenced greatly by changes in the feed mix due to changes in relative prices of feed grains or by-product feeds.
- Feed accounts for about 70 percent of total inputs in poultry.

On the reasonable assumption that quality improvements in birds, feed, and management are reflected in feed efficiency gains, the feed measure picks up these benefits of research. However, several other benefits of poultry research are not reflected in feed efficiency gains. These include:

1. Savings in labor obtained by substituting medication in feed for frequent cleaning and disinfecting of poultry housing.
2. Savings in labor and durable inputs in broiler production because of a rapid growth rate.
3. Savings in labor due to improved poultry housing and equipment.
4. Any decrease in cost of purchased inputs resulting from poultry research (e.g., a reduced cost of chicks of a given quality because of higher egg production in hatchery supply flocks).

On the other hand, the feed efficiency measure apparently does not reflect any major productivity gains stemming from factors unrelated to poultry research. Thus, measuring feed saved in the production of poultry products should result in an underestimate of returns to poultry research.

Total Factor Productivity

An alternative method of measuring productivity gains is to relate longrun changes in prices of inputs to changes in product prices. A decline in the product price relative to input prices indicates productivity gains in the production process.

Subtracting the percentage change in product price from the percentage change in input prices results in a measure of change in total factor productivity. In the period following World War II, poultry product prices declined relative to poultry input prices (see table 2), indicating a gain in total factor productivity.

This total productivity measure picks up three of the four mentioned benefits of research that are not caught by the feed efficiency measure. However, it does not account for any decrease in poultry input prices (over what they would otherwise be) stemming from poultry research. With this substantial downward bias, the total productivity measure probably underestimates benefits of poultry research.

The estimated net social returns to poultry research obtained from the two productivity measures for selected years are presented in table 3. Since we subtracted the value of new inputs (e.g., feed additives and drugs) used by farmers to achieve these productivity gains, the figures represent *net* social returns. These figures can be thought of as the value of resources saved in the production of poultry products because of research-induced productivity gains.

Table 1. Indexes of poultry output per feed unit (1930-34 = 100)

Period	Layers	Broilers	Turkeys
1930-34	100	100	100
1935-39	109	104	109
1940-44	110	109	111
1945-49	119	120	124
1950-54	128	141	139
1955-60	138	153	140

Sources: Calculated from USDA Production Res. Rpts. 21 and 29.

Table 2. Indexes of poultry input and product prices (1935-39 = 100)

Period	Inputs	Eggs	Broilers	Turkeys
1935-39	100	100	100	100
1940-44	131	136	118	148
1945-49	224	205	162	217
1950-54	247	202	137	191
1955-60	232	177	98	148

Sources: Calculated from USDA, *Agricultural Statistics*, 1957 and 1962.

Table 3. Estimated annual value of net social returns to poultry research, selected years, 1940-60

Year	Feed efficiency measure	Total productivity measure
	millions of 1958-60 dollars	
1940	46	12
1945	188	91
1950	461	400
1955	598	878
1960	494	904

Research Expenditures

Data on total research expenditures by state experiment stations are complete and readily available. But this is not true for individual commodities. With respect to experiment station research on poultry production, USDA data are available for 1951 on. To estimate poultry research expenditures prior to 1951, we assumed that the percentage of total experiment station research expenditures on poultry was equal to the percentage of poultry research workers. Data on poultry research expenditures by USDA are also available for most years.

Perhaps the most difficult data to obtain are poultry research expenditures by industrial firms. According to available information, private research by industrial firms has been equal in magnitude to public poultry research.

To estimate expenditures on poultry extension activities, we multiplied the percentage of extension workers' time by total extension expenditures available. All poultry research expenditures were adjusted by an index of professors' salaries to take account of changes in price levels over the years (table 4).

Alternative Rates of Return

To obtain a rate of return to research expenditures, we then related estimates of annual value of net social returns to annual research expenditures. We sub-

Table 4. Estimates of poultry research expenditures in the United States, selected years, 1915-60

Year	State experiment station research	USDA research	Extension expenditures	Private research	Total
	millions of 1958-60 dollars				
1915	1.5	.....	1.5	1.5	4.5
1930	2.4	.3	5.0	2.7	10.4
1940	2.5	.9	3.1	3.4	9.9
1950	3.9	1.2	3.1	5.1	13.3
1960	5.9	1.8	2.4	8.3	18.4

Table 5. Average social rates of return to poultry research in the United States

	Feed efficiency measure	Total productivity measure
	percent per year	
Research including extension	18	14
Research excluding extension	21	17

tracted research costs from net social returns to obtain a net cash-flow for each year. Annual cash-flows were negative up to the mid-1930's when research costs exceeded net returns, but they turned positive as research began to yield benefits. A 20-percent rate of return, for example, means that, on the average, each dollar invested in poultry research returns 20 cents per year from the date invested into the future. Of course, for some research dollars the return is zero and for others the return far exceeds the average.

Because we were not sure how to treat extension in a study of this type, we calculated alternative rates. It might be argued that extension must be included because new inputs cannot be adopted unless farmers know about them. But extension could be left out because new inputs stemming from research would be adopted by farmers eventually due to their profitability and other informational sources.

Alternative rates of return including and excluding extension expenditures are presented in table 5. It is difficult to say that one rate of return is closer to the true rate than another. Nevertheless, we believe that these estimates represent alternative **lower bounds** of the return to poultry research because:

- Many benefits are not caught by the two measures of productivity used.
- In the rate of return calculation, we assumed that the 1958-60 level of research would continue into the future but there would be no additional productivity gains. Therefore, all future research would just maintain the current stock of knowledge and nothing more—a very conservative assumption.

Therefore, past investment in poultry research apparently is paying off at the rate of 18 to 20 percent per year at the very minimum. If a 10-percent return is considered an acceptable return to ordinary investment, past investment in poultry research is paying high dividends. This fact has an important bearing on the economic growth issue. There is little fuel for economic growth in investments yielding 3 or 4 percent. High payoff investments—those yielding high rates of return—hold the key to economic growth both in developed and developing nations. ■

Turkey Production . . .

(Continued from page 1)

How do consumers vary their purchases of turkey in response to changes in its price? Results of a recent study by the Department of Agricultural Economics indicate that consumers respond more to turkey price changes in the nonholiday period than during November and December.

Consumers appear to be most responsive to price changes during the summer months. Because turkey and other meats are close substitutes during summer, consumers buy the meat that is cheapest. During this period, a 10-percent decrease in turkey prices results in a 10- to 15-percent increase in purchases. But a 10-percent decline in price during November or December results in only about a 5-percent increase in purchases.

This situation seems reasonable; turkey is the traditional meat of the holidays so consumers buy their usual amount unless prices increase or decrease greatly. During the late winter and early spring, consumer response to turkey price changes is about halfway between the two extremes. Therefore, a 10-percent decline in price results in an 8- to 10-percent increase in purchases.

Consumer response to price changes affects total revenue to producers. If consumers respond to a 10-percent price decrease by increasing purchases more than 10 percent, total revenue to producers increases. The opposite, of course, is true if consumers increase their purchases less than 10 percent.

Apparently, turkey producers might increase their sales and incomes the most by stimulating consumption in the nonholiday season. Further processed turkey probably offers the most promise in this direction. ■

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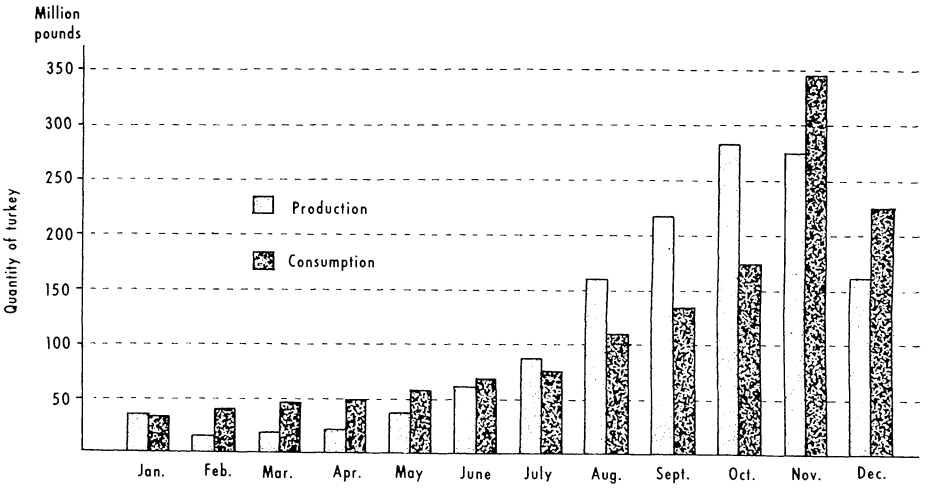

Average monthly production and consumption of turkey, 1960-65.

Annual U.S. production, consumption, and price of turkey, selected years, 1930-65

Year	Production	Consumption		Farm price	
		Per capita	Percent of total meat	Actual	Adjusted*
	million pounds	pounds		cents	
1930	178	1.5	1.1	20.2	34.7
1940	392	2.9	1.9	15.2	31.1
1950	615	4.1	2.4	32.9	39.3
1960	1,162	6.2	3.2	25.4	24.6
1965	1,508	7.4	3.6	22.4	20.4

* Deflated by the Consumers Price Index (1957-59 = 100) to account for changes in the general price level.

Source: USDA, *Selected Statistical Series for Poultry and Eggs through 1965*, ERS Rpt. 232.

In perspective

Trends in Turkeys and Eggs

Clark R. Burbee

The poultry industry is one of the most dynamic in U.S. agriculture. Numerous advancements in technology and organizational structure have increased operational efficiency, reduced prices for poultry meat and eggs, and expanded output and consumption of poultry meat. Shifts in production locations have accompanied these changes, with considerable impact on several regions including the Midwest and Minnesota.

Turkeys

Per capita consumption of turkey has increased steadily, from 4.1 pounds in 1950 to 7.6 pounds in 1966. An increasing percentage of total consumption is in further processed forms. Compared to only 11 percent in 1960, 23 percent of the output was further processed in 1966.

The shift to further processing should continue and will affect both turkey prices and market classes. While the demand for Tom turkeys used for further processing will increase, the price premium paid for small, "consumer sized," whole turkeys will diminish.

Production has increased in established areas as well as in several other regions. The Western and West North Central States still produce over half of the national output. California, Minnesota, and Missouri, the top three producing states, account for two-thirds of the output in these two regions and one-third of U.S. production.

Since 1960, turkey production has expanded rapidly in the South Atlantic and South Central Regions with an average increase of 14.6 and 16 percent per year, respectively. These regions now account for 30 percent of total U.S. output. In comparison, production in the Western, West North Central, and East North Central Regions expanded 3.3, 4.0, and 4.5 percent per year, respectively. The West North Central Region is the largest producer with 32 percent of the total; it is followed by the Western Region with 22 percent and the East North Central Region with 14 percent.

Turkey production is becoming increasingly important in the South because of (1) low labor and feed transportation costs and (2) the knowledge acquired from, and modern facilities developed for, broiler and egg industries. Much of this expansion may be at the expense of several surplus producing Western States.

Minnesota, Missouri, and several other Midwest States also should increase output. Besides a locational advantage for feed ingredients, the industry is situated close to major markets and should remain competitive.

Eggs

Per capita egg consumption has declined since 1945, reaching a low of 301 eggs in 1966—a 25-percent decrease. Although prices have declined and incomes and population have increased, aggregate civilian utilization has remained close to 5 billion dozen per year for the last 10 years.

Compared to 6 percent 20 years ago, 10 percent of current egg consumption is in processed forms. Per capita consumption of processed eggs has increased at a slow rate and is equivalent to 30 shell eggs per year. Processed eggs are finding increased use in convenience foods; consumption should continue to increase but not at a rate sufficient to reverse the overall egg consumption trend. Per capita shell egg consumption is expected to decline from its current 270 eggs a year but at a slower rate than in the past.

Historically, the Midwest has been the major surplus egg-producing region in the United States. Since the mid-1950's, the situation has changed rapidly. In the 1955-65 period, the Midwest lost numerous markets outside the region while the South Atlantic, South Central, and Western Regions increased output 94, 73, and 49 percent, respectively. These regions are now surplus; the South competes with the Midwest for the heavily deficit North Atlantic market.

The Midwest is also in danger of losing its dominant position as a producer of eggs for processing. About 25 percent of the plants breaking and freezing eggs are now in the South compared to only 7 percent in 1960. The percentage of plants in the Midwest has declined from 88 to 66 since 1960.

Production in the Midwest declined rapidly during the 1955-65 period, by 21 percent in the East North Central Region and 32 percent in the West North Central Region. Minnesota production declined 42 percent. Although the East North Central Region is deficit, the West North Central Region remains a major surplus producer.

The problem in the Midwest is the industry's failure to make some cost-reducing adjustments. Because eggs are a secondary source of income to farmers, a large number of small flocks are scattered throughout the region. Consequently, input costs are high and the marketing system is inefficiently organized and expensive. In addition, there are egg quality problems.

Egg production will continue to decline until small producers are replaced by specialized large-scale producers in concentrated areas. If the Midwest is to retain its position as a surplus producer of eggs, this adjustment must be accompanied by increased efficiency in the input and egg marketing systems. ■

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