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The Impact of Agricultural Research

A. A. Araji and R. W. Schermerhorn

Public investment in research has been the foundation of technological development in the United States. The agricultural experiment station system — a system that includes extensive state and USDA cooperation — has contributed greatly to the scientific and technological advances in agriculture. These advances have, for decades, sustained productivity and made U.S. agriculture the most efficient agricultural industry in the world.

A 1982 report by the Executive Office of the President shows that annual rates of return to public investments in agricultural research range between 35 and 50 percent. This is well above returns to other public investments and a clear indication that we are seriously underinvesting in this national resource.

While payoff to public investments in agricultural research has been documented at the national level, the impact of agricultural research on state and regional economic development has not been fully demonstrated. This publication answers such questions as:

1. Who benefits from public investments in agricultural research and extension?
2. What is the impact of public investments in agricultural research and extension on agricultural productivity?
3. How does agricultural research contribute to international trade and the U.S. balance of payments?
4. How does agricultural research affect employment levels?
5. Has agricultural research been compatible with national and state policy on the environment?
6. What role does extension play in enhancing the productivity of public investment in research?
7. What is the impact of reduction in public funding for agricultural research and extension?

To answer these questions, we have examined some specific research and extension programs in Idaho, the Western Region and the U.S.

Investment in Potato Storage Research

Potato storage research was initiated by the Idaho Agricultural Experiment in 1958. By 1973, the research program was essentially completed and implemented by Idaho potato producers, processors and shippers. Results of this research had also been widely adopted nationally and internationally.

The accumulated compounded costs of the research program over these 15 years totaled $2,162,714. Average cost per year was $144,180.

Benefits to the State of Idaho

The potato storage research program developed technology for storing potatoes with minimimum physical loss and optimal quality. A survey of Idaho potato producers, shippers and processors in 1976 showed that implementation of the new storage technology had reduced shrinkage and weight loss by 15 percent, reduced spoilage and sprouting by 3 percent and increased the recovery ratio of stored potatoes that are processed by 16.6 percent (Araji and Sparks 1977).

These savings produced direct benefits to Idaho potato producers, shippers and processors estimated at 11,692,080 cwt at the 1974 production level, or $44.4 million annually. If we apply the same percentages to 1980 production, the direct benefits exceeded 11,297,520 cwt, or $62.81 million annually.

In addition, Idaho potato processors recovered 6,825,446 cwt annually of additional potatoes, measured at the 1974 processing level, because of the improved recovery ratio of stored potatoes for processing. At 1974 prices for unprocessed potatoes, this meant annual savings to Idaho processors of an estimated $25.9 million. At the 1980 quantity and price, the savings was estimated to be 6,590,220 cwt, or $37.23 million. These figures do not include the additional savings the processors gained from more efficient use of labor and fixed facilities.

In addition to benefits resulting from quantity savings, the new potato storage technologies improved stored potato quality and extended the processing period. The new storage technologies reduced the sugar content of stored potatoes

that resulted in production of lighter colored french fries. Improved quality increased demand for french fries by fast food chains. The quality impact, however, of the new storage technology is hard to quantify and thus is not included in assessing the benefit of investment in the potato storage research.

A survey of Idaho potato processors in 1976 showed that the new storage technology was credited with extending processing time 7.2 weeks per year. This increased employment by 1,129,440 person hours per year, and generated an annual payroll increase of $4,054,689 measured at the 1974 wage rate and $6,776,640 measured at the 1980 wage rate. The total annual economic impact of increased employment on the state economy is estimated to exceed $6,416,545 at the 1974 wage rate and $10,707,091 at the 1980 wage rate.[1]

[1]The total economic impact of increased employment in the Idaho potato processing industry on the Idaho economy was estimated by using .75 marginal propensity to consume and an employment multiplier of 2.11.

Employment created by constructing new storage facilities was not considered in assessing the employment impact of the potato storage research.

Consequences of Budget Cuts On the Economic Impact Of Potato Storage Research

The average cost of developing the new potato storage technology was $144,180 per year. The analysis of benefits shows that each year delay in completing this research project would have cost the State of Idaho $74.4 million per year in real income measured at the 1974 production and price levels and $106.8 million per year measured at the 1980 production and price levels. In other words, each $1 reduction in funding for this research project would have cost the State $516 in real income, at 1974 production and price levels, and $740, measured at 1980 levels. The rate of return for public investment in this research is estimated to exceed 900 percent.

Investment in the DHI Extension Program — Impact on the State and Regional Economy

The Dairy Herd Improvement program is one of the oldest programs developed by the Cooperative Extension Service. It is designed to increase milk production efficiency through improved management. The program emphasizes the development of centralized records for milk production and feed rations, breeding history and herd testing procedures, and sire and cow performance indexes to aid in genetic improvement. Through genetic improvements of the dairy herds, proper nutrition and implementation of modern management techniques, the DHI program has significantly increased milk production efficiency for DHI herds. The direct economic impact of extension investment in the DHI program is evaluated by isolating and excluding the effect of management and herd size. (For a detailed analysis of this program, see Araji and Gardner 1981.)

Benefits of the DHI Program

In 1976, the Cooperative Extension Services in the Western Region invested $388,266 in the DHI program. Idaho's share of this investment was $34,213. As a direct benefit of this program, excluding the effects of management and herd size, milk production increased 5.1 percent in the Western Region and 2.8 percent in Idaho. Increase in **net income** measured at the 1976 milk price, directly because of the DHI program, was $42.55 per cow in the DHI program. Thus, the annual increase in **net income,** directly caused by the DHI program, was $25.3 million in the Western Region and $444,000 in Idaho.

Every $1 reduction in Extension investment in the DHI program will reduce **net income** for dairy farmers and the State of Idaho by $13, measured at 1976 price and production levels. For the Western Region, every $1 reduction in budget for the DHI program will cost the region $65 per year in **net income.**

Consumers are the direct beneficiary of extension investment in the DHI program. Consumers in the Western Region benefited by an estimated $142,730,000 in 1976. In other words, without the 5.1 percent increase in milk production directly attributed to the DHI program, consumers in the Western Region would have been willing to pay $142,730,000 more than they actually paid to purchase milk and milk products in 1976.

The annual internal rate of return to extension investment in the DHI program in the Western Region is estimated at 34 percent. In 1976, an estimated $4,629,991 was allocated to all dairy research programs in the Western Region. Considering the investment in all dairy research programs, the annual internal rate of return is 26 percent. In other words, the return from the DHI program alone covers the costs of all dairy research plus 26 percent return on investment.

Investment in Wheat Research in the Western Region, 1939-74 — Impact on the Region's Economy

The Western Region produces 22 percent of the United States wheat. During the 1939-74 period, a total of $66.1 million of public funds were invested in wheat research in the Western Region. About 55 percent of this investment was allocated to the breeding program and 45 percent to other wheat research.

Benefits of Investment in Wheat Research

One direct result of investment in wheat research was development of 92 new wheat varieties by the Western Region Agricultural Experiment Station and USDA cooperative system. Nineteen of these were developed by the Idaho Agricultural Experiment Station and USDA system. An estimated 29.2 percent increase in wheat yield is directly attributed to wheat research during the 1939-74 period (Sim and Araji 1981). The internal rate of return to investment in wheat research in the Western Region during this period is estimated at 41.3 percent.

During the 1939-74 period, wheat research in the Western Region contributed an estimated $3.6 billion to consumer welfare, or $222.7 million annually measured at the 1967 price and 1974 production level. Improved efficiency in wheat production has enhanced the comparative advantage of the U.S. in the world wheat market. Wheat accounts for 14 percent of all U.S. agricultural exports. Wheat research in the Western Region contributed an estimated $1.9 billion to the U.S. balance of payments during the 1939-74 period, or $170.2 million annually measured at 1967 price and 1974 production.

Impact of Research Through Time

The wheat breeding research program accounted for 55 percent of the increased wheat yield in the Western Region; other wheat research accounted for 45 percent. The initial impact of wheat research on yield takes place 4 years after the initial investment, with maximum impact occurring after 6 years. The impact of research on yield will continue for 5 years after the initial impact but at a decreasing rate after the sixth year. In fact, the impact of research on increased yield will approach zero 9 years after the initial investment (Fig. 1).

Thus, the maximum wheat yield attained the sixth year after the initial investment has to be maintained or improved through implementation of results of new research. In other words, agricultural experiment station research is a dynamic and systematic process directed to provide new scientific knowledge to maintain and/or update the productivity of presently implemented technology. The productivity of soft red winter wheat in the Midwest is being maintained and improved through time by a well-planned breeding program that replaces the mother variety every 5 years (Fig. 2).

Fig. 1. Research impact on wheat yield, Western Region, 1939-1974.

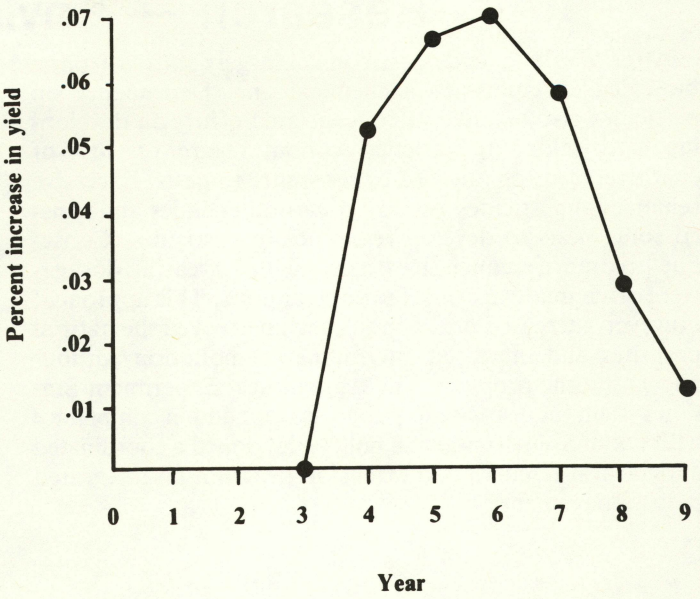
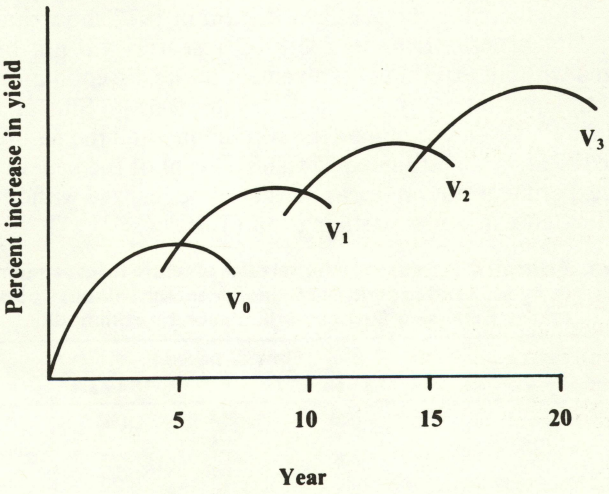


Fig. 2. Research impact on soft red winter wheat, Midwest.



Investment in Livestock Research, 1961-78 Impact on Consumers and Producers

From 1961 through 1978, an estimated $284,550,000 were invested in beef research and $146,900,000 were invested in swine research in the United States. The results of beef research during this period contributed a total of $4,757,570,000 to society welfare measured at 1967 prices (Kim and Araji). Consumers benefited by an estimated $1,877,610,000 and producers benefited by an estimated $2,880,140,000. The implementation of the results of swine research contributed a total of $3,544,970,000 to society welfare during this period measured at 1967 prices. Consumers benefited by an estimated $1,480,170,000 and producers of swine benefited by a total of $2,064,800,000.

Investment in Integrated Pest Management Research — Environmental Impact

After World War II, pest control largely shifted from a biological discipline to a chemical one. Dependence on pesticides also resulted in concentrated effort on developing high-yield crop varieties without regard for loss of characters for tolerance of or resistance to pests. Excessive reliance on pesticides destroyed natural enemies and caused some pests to develop resistance to pesticides. Consequently, more frequent treatments with increasing dosages were often made in efforts to control pests. This approach, however, increased production costs, destroyed the natural parasites and increased environmental pollution without alleviating the problem. The Agricultural Experiment Station system, in response to public concern and in compliance with national environmental policy, developed a coordinated agricultural research and extension program on integrated pest management.

Direct benefits of public investment in this program are twofold: (1) Production costs are reduced by eliminating excessive use of pesticides and increasing yield through better management of pests. (2) Significantly fewer active toxic materials are put into the environment. (For a detailed study of this program, see Araji 1981.)

Evaluation of the economic impact of investment in integrated pest management for 30 agricultural crops shows that the internal rates of return to investment in this program range between 7.2 and 100 percent, depending on the crop and the nature of the pest. In addition, implementing an IPM program eliminates the use of 37.4 million pounds of active toxic materials on 20 crops per year. This reduction in active toxic materials from the environment will enhance the population of parasite species and will lead ultimately to 70 percent reduction in pesticide use.

The Role of Cooperative Extension Service In the Effectiveness of Research

The Cooperative Extension Service is the marketing arm of Agricultural Experiment Station research. Results of a survey conducted in the Western Region in 1977 show that significant benefits from agricultural research will not be realized without extension involvement in the dissemination and implementation of research results (Araji, Sim and Gardner 1978). Depending on the commodity and the nature of the research, an estimated 25 to 66 percent of the benefits from experiment station research will not be realized without coordinated extension participation (Table 1).

Table 1. Estimated decrease in internal rates of return to investment in Agricultural Experiment Station research without Cooperative Extension Service participation by commodity.

Commodity	Flow of benefit	
	13 years	18 years
	(%)	(%)
Sheep	28	25
Lettuce	30	23
Tomatoes	34	22
Grapes	52	45
Apples	30	28
Citrus fruits	—	40
Potatoes	33	33
Cotton	58	51
Rice	66	40

Literature Cited

Araji, A. A. 1981. The economic impact of investment in integrated pest management. Idaho Ag. Exp. Sta. Res. Bull. 115.

Araji, A. A., and R. L. Gardner. 1981. Economic evaluation of the DHIA in the Western Region. Idaho Ag. Exp. Sta. Buli. 117.

Araji, A. A., R. J. Sim and R. L. Gardner. 1978. Returns to agricultural research and extension programs. Am. J. of Ag. Econ. 60:5.

Araji, A. A., and W. C. Sparks. 1977. Economic values of agricultural research — A case study: Potato storage research. Idaho Ag. Exp. Sta. Res. Bull. 101.

Kim, C. S., and A. A. Araji. *In progress.* Multimarket equilibrium approach to evaluating the impact of technical change. Idaho Ag. Exp. Sta. Bull.

Sim, R.J., and A. A. Araji. 1981. The economic impact of public investment in wheat research in the Western Region, 1939-74. Idaho Ag. Exp. Sta. Bull. 116.

The Authors

A. A. Araji is a professor of agricultural economics, and R. W. Schermerhorn is head and extension professor of agricultural economics. Araji is in the Department of Agricultural Economics, Moscow, and Schermerhorn is on leave as head of the same department.

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