RETURN TO PUBLIC INVESTMENT AND THE BENEFIT OF RESEARCH TO CONSUMERS AND PRODUCERS OF WHEAT

by

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Introduction

Wheat is one of the principle commodities in the diets for the world population. World wheat output accounts for about 19 percent of the world's calories produced from crops. It is second only to rice. During the 1984-1987 period wheat production in the United States represented 12.3 percent of the world's total wheat production. Wheat exports from the United States during this period accounted for 35.3 percent of the world's total wheat export and represented 53.1 percent of the United States total wheat production (USDA 1988).

The Western Region[11/] of the United States is a major wheat-producing area, accounting for over 26 percent of the nation's wheat production and more than 25 percent of the United States wheat exports. An estimated 70 percent of the soft white wheat produced in the United States is exported (USDA 1987). The Pacific Northwest states of Idaho, Oregon and Washington produce 83.4 percent of the soft white wheat in the United States. Soft white wheat production represents 85.8 percent of the sub-region's total wheat production (USDA 1982). In general, the international market is the major source of demand for the United States and the Pacific Northwest wheat.

The comparative advantage of the United States in the international wheat market is influenced by many factors. All evidence, however, tends to suggest that research and evolving technologies are the principal factors contributing to efficiency in wheat production and thus the comparative advantage of the United States in the world's

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11/ The states in the Western Region included in this study are: Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

wheat market. Increase in wheat production attributed to research would be largely reflected in increased export receipts (Finn 1987).

The objectives of this paper are: (1) to evaluate the impact of research on increases in wheat yields in the Wester Region, (2) to estimate the rate of return to public investment in wheat research in the Western Region, and (3) to evaluate the benefits of investment in wheat research to Western wheat producers, domestic wheat consumers, and foreign consumers of Western wheat.

The Impact of Research on Increased Wheat Yields in the United States

A systematic approach to the problem of measuring wheat yield changes in the United States during the 1939-61 period was taken by Auer and Heady (1968). They estimated that 27.7% of the increase in wheat yield was attributed to genetic improvement, 43.3% was due to fertilizer and 28.9% was due to other sources. The technology of wheat production has advanced rapidly since that time.

The results of recent studies show that wheat breeding and varietal development are the principle research functions contributing to increases in yield. An estimated 50 percent of the increase in wheat yield in the United States during the 1958-80 period was attributed to genetic improvement (Schmidt 1984). During the 1956-84 period genetic improvement accounted for 55 percent and 40 percent of the increased wheat yield in the Southern and Northern Regions of the United States, respectively (Peterson et al. 1985). All the increase in yield in the Western Region during the 1956-84 period was attributed to genetic improvement (Peterson and Morrison 1986).

Feyerherm and Kemp (1988) show that during the 1954-79 period, genetic improvement contributed 43 percent and 74 percent of total wheat yield changes in the Great Plains and Cornbelt states, respectively. Applied nitrogen represented 23 percent

and 22 percent of increases in wheat yields in the Great Plains and Cornbelt states, respectively. The estimated contribution of other factors was 35 percent for the Great Plains states and only 3 percent for the Cornbelt states. The results of their study also show that by extending the analysis through 1984 the contribution of genetic improvement to increases in wheat yields in the Great Plains states increased to 61 percent.

It is apparent that the impact of genetic improvement on wheat yield differs substantially among regions. Feyerherm et al. (1984) documented that the pace of genetic improvement is highest in regions where environmental limitations are lowest.

During the 1930-81 period, an estimated 321 new wheat varieties were released by the State Agricultural Experiment Stations and the United States Department of Agriculture and registered in the United States. An estimated 37.7 percent of these varieties were developed and released by Agricultural Experiment Stations in the Western Region. Wheat varieties developed by the Agricultural Experiment Stations in the Western Region are planted in 25 states. (Crop Science Society of America 1982).

Investment in Wheat Research

In the Western Region

Public expenditures on wheat research in the Western Region represent more than 33 percent of the total United States public investments in wheat research. Public investments in wheat research are directed toward two principle areas: (1) breeding and varietal improvement and (2) management practices research. For the period 1951-87, an average of 21.5 percent of public investment in wheat research in the Western Region was allocated to breeding and varietal improvement and 78.5 percent to management practices (Current Research Information System). However, the proportion of public investments in wheat research allocated to breeding and varietal improvement increased

from 7.8 percent in 1951 to 38.5 percent in 1987.

In 1987 a total of $11,754,973 was invested in total wheat research by the Western Region's Agricultural Experiment Stations in partnership with the United States Department of Agriculture. About 61 percent of the research expenditures on wheat is from state sources and 39 percent from federal sources (Table 1). An estimated $4,500,071 of the total research expenditures on wheat was allocated to breeding and varietal improvement research with 53 percent from federal sources and 47 percent from state sources. An estimated 76.8 scientific man years were allocated to wheat research by the Western Agricultural Experiment Stations. An estimated 32 scientific man years were allocated to breeding and varietal improvement research.

In 1987 the Pacific Northwest States (PNW) of Idaho, Oregon and Washington accounted for 41 percent of the total investment in wheat research by the Western Agricultural Experiment Stations. About 72 percent of the PNW states' investment in wheat research was from state sources and 28 percent from federal sources (Table 1).

The Impact of Research on Increased Wheat Yields in the Western Region

The impact of research on wheat yield in the Western Region was analyzed for the 1951-87 period. Analysis of the impact of research on wheat yields shows that 76 percent of the increase in wheat yield in the Western Region during this period is attributed to public investment in total wheat research. Increases in wheat yield attributed to breeding and varietal improvement research was 56 percent and to management practices research was 20 percent (Table 2).

The results of this study also show that breeding and varietal improvement research influences wheat yield for 10 years, with peak impact occurring in year 5 and declining thereafter. About 78 percent of the breeding research impact on yield was

realized during the first seven years. Management practices research influenced wheat yield for 12 years with the peak impact occurring in year six. About 76 percent of the research impact on yield was realized in the first eight years. Total wheat research influenced wheat yield for 12 years with the peak impact occurring in the sixth year after the initial investment. About 76 percent of the research impact on yield was realized in the first eight years.

The Benefits of Public Investment In Wheat Research

The benefits of public investment in wheat research were estimated using the number of years that research impacted yields. Table 2 shows the annual rate of return to public investment in wheat research conducted by the Western Agricultural Experiment Stations during the 1951-87 period. The annual rate of return on total investment in wheat research was estimated at 42 percent. The rate of return on investment in breeding and varietal improvement research was 71 percent and that for management practices research was 29 percent. In general public investment in wheat research is highly rewarding to society.

Distribution of Benefits

The producers and consumers of wheat benefit from the increase in wheat production attributed to research. Since a significant portion of the wheat produced in the Western Region is exported, foreign consumers will benefit from wheat research as well as domestic producers and consumers. The extent of benefit to each group will depend upon the following factors:

1. Percentage increase in wheat production attributed to research
2. Total demand for wheat (D_T)

3. Domestic demand for wheat (D_d)

4. Export demand for wheat (D_f)

5. Domestic price response to changes in wheat production (E_d)

6. Export price response to changes in wheat production (E_f)

7. Supply response to changes in price

The weighted average price response to changes in wheat production (E_D) is expressed in the following equation:

$$E_D = E_d \frac{D_d}{D_T} + E_f \frac{D_f}{D_T}$$

These factors were used in an economic model to calculate the benefit of public investment in research to Western wheat producers, domestic wheat consumers and international consumers of Western wheat. Economists are in general agreement that there is a -.2 domestic price response to changes in quantity. It indicates that for every 1 percent decrease in price of wheat the quantity demanded by domestic consumers will increase by .2 percent. However, several estimates for long-run export price response to quantity changes are available. They are (1) -6.72 estimated by Johnson (1977), (2) -5.00 estimated by Miller and Washburn (1978) and also by Holland and Sharples (1984), (3) -2.30 estimated by Liu and Roningen (1985) and (4) -1.82 estimated by Paarlberg (1983). For soft white wheat only one price response of -7.4 is available (Taplin).

In this study, for all wheat several weighted average price responses were used in estimating the benefits of research to producers, domestic consumers and foreign consumers. Very high price response of -3.88, high price response of -2.91, medium price response of -1.38 and low response of -1.11 were used. For soft white wheat only one weighted average price response of -5.29 was used. For high price response,

producers benefit relatively more and consumers benefit relatively less. The reason for this result is that the price would drop very little in response to higher wheat yields. A wheat supply response of .3, which is generally accepted by economists, was used in this study.

The results shown in Table 3 indicate that Western wheat producers benefit the most from public investment in wheat research. Foreign consumers and domestic consumers ranking second and third, respectively, in benefits received. Wheat producers receive between 47 to 77 percent of the benefits attributed to research, depending on the price response to quantity changes. An estimated 75 percent of the total benefits attributed to public investment in wheat research is from breeding and varietal improvement research. Wheat producers receive between 66 to 75 percent of the benefits attributed to public investment in wheat research from breeding and varietal improvement research.

For soft white wheat, western producers are the major beneficiaries of wheat research, because such a large share of the product is exported (88.2 percent) making the weighted average price highly responsive to change in quantity of wheat produced. As a result of western research on soft white wheat, economic benefits would increase $216.2 million for western producers, $16.4 million for U.S. consumers, and $54.9 million for foreign consumers.

Summary

The results of this study show that investment in wheat research during the 1951-87 period increased wheat yield in the Western Region by 76 percent. Increase in wheat yield attributed to varietal improvement research and to management practices research was 56 percent and 20 percent, respectively. In other words, over 73 percent of the increase in wheat yield attributed to public investments in wheat research was

accounted for by breeding and varietal improvement research and less than 27 percent was accounted for by management practices research.

Returns to public investment in total wheat research in the Western Region during the 1951-86 period was 40 percent. Returns to breeding and varietal improvement research was 71 percent and to management practices research was 29 percent. Wheat producers, domestic consumers and foreign consumers benefit from public investment in wheat research. Most of the benefit, however, is captured by wheat producers, with foreign consumers and domestic consumers ranking second and third, respectively.

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