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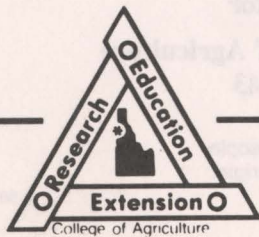
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# The Benefit of Research



# to Producers and Consumers of Western Wheat

A. A. Araji and F. C. White



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# The Benefit of Research to Producers And Consumers of Western Wheat

A. A. Araji and F. C. White

Wheat is a principal commodity in the world's diets. Wheat accounts for about 19 percent of the world's calories produced from crops. It is second only to rice.

During the 1984-87 period, the United States produced 12.3 percent of the world's wheat. Wheat exports from the United States during that period accounted for 35.3 percent of the world's total wheat exports and 53.1 percent of the United States's total wheat production (U.S. Department of Agriculture 1988). The western region<sup>1</sup> of the United States is a major wheat-producing area, growing over 26 percent of the nation's wheat and more than 25 percent of its wheat exports.

An estimated 70 percent of the soft white wheat produced in the United States is exported (U.S. Department of Agriculture 1987). The Pacific Northwest states of Idaho, Oregon and Washington produce 83.4 percent of the nation's soft white wheat. Soft white wheat accounts for 85.8 percent of this subregion's total wheat production (U.S. Department of Agriculture 1982). In general, the international market is the major source of demand for United States and Pacific Northwest wheat.

The comparative advantage of the United States in the international wheat market is influenced by many factors. Yet all evidence tends to suggest that research and evolving technologies are the principal factors contributing to efficiency in wheat production and thus to the comparative advantage of the United States in the world's wheat market. The increase in wheat production attributable to research would be reflected largely in increased export receipts (Finn 1987).

The objectives of this paper are (1) to evaluate the effect of research on increases in wheat yields in the western region, (2) to estimate the rate of return to public investment of 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 Effect of Research on Increased Wheat Yields in the United States

Auer and Heady (1968) took a systematic approach to the problem of measuring wheat yield changes in the

United States during the 1939-61 period. They estimated that 27.7 percent of the increase in wheat yield was due to genetic improvement, 43.3 percent was due to fertilizer and 28.9 percent was due to other factors. Since that time, the technology of wheat production has advanced rapidly.

Recent studies show that wheat breeding and varietal development are the principal 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 attributable to genetic improvement (Schmidt 1984).

During the 1956-84 period genetic improvement accounted for 55 percent of the increased wheat yield in the southern region of the United States and for 40 percent in the northern region. The entire increase in yield in the western region during that period was attributable to genetic improvement (Peterson and Morrison 1986).

Feyerherm and Kemp (1988) showed that during the 1954-79 period, genetic improvement contributed 43 percent of total wheat yield changes in the Great Plains states and 74 percent of total wheat yield changes in the Corn Belt. Applied nitrogen caused 23 percent and 22 percent of increases in wheat yields in the Great Plains and Corn Belt states, respectively. The estimated contribution of other factors to wheat yield changes was 35 percent in the Great Plains states and only 3 percent in the Corn Belt. Extending the analysis through 1984, the researchers showed that the contribution of genetic improvement to increases in wheat yield in the Great Plains states rose to 61 percent.

The effect 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 U.S. 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).

<sup>1</sup>The states in the western region included in this study are Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming.

## Investment in Wheat Research In the Western Region

Public expenditures on wheat research in the western region account for more than 33 percent of the total United States public investment in wheat research. Public investments in wheat research are directed toward two principal areas: (1) breeding and varietal improvement and (2) management practices. During the 1951-87 period, an average 21.5 percent of public investment in wheat research in the western region was allocated to breeding and varietal improvement and 78.5 percent was allocated to management practices. The proportion of public investment in wheat research allocated to breeding and varietal improvement increased from 7.8 percent in 1951 to 38.5 percent in 1987.<sup>2</sup>

In 1987, \$11,754,973 was invested in wheat research conducted by the western region's agricultural experiment stations in partnership with the U.S. Department of Agriculture (Table 1). About 61 percent of the research expenditure was from state sources, and 39 percent was from federal sources. An estimated \$4,500,071 of the total research expenditure on wheat was allocated to breeding and varietal improvement research, with 53 percent from federal sources and 47 percent from state sources.

Also in 1987, an estimated 76.8 scientific man years were allocated to wheat research conducted by the western agricultural experiment stations (Table 1). About 32 scientific man years were allocated to breeding and varietal improvement research.

<sup>2</sup>Research expenditures on wheat from 1967 to 1987 were obtained from the U.S. Department of Agriculture Current Research Information System (CRIS). Research expenditures before 1967 were obtained from the USDA Agricultural Research Service and the Cooperative State Research Service.

Research in Pacific Northwest states of Idaho, Oregon and Washington accounted for 41 percent of the total investment in wheat research by the western agricultural experiment stations in 1987. About 72 percent of these states' investment in wheat research was from state sources, and 28 percent was from federal sources (Table 1).

## The Effect of Research on Increased Wheat Yields in the Western Region

We analyzed the impact of research on wheat yield in the western region for the 1951-87 period. Our analysis shows that wheat yield increased by 76 percent during that period as a result of public investment in total wheat research. Breeding and varietal improvement research increased yield by 56 percent, and management practices research increased yield by 20 percent (Table 2 and Fig. 1).

Our results also show that breeding and varietal improvement research influenced wheat yield for 10 years

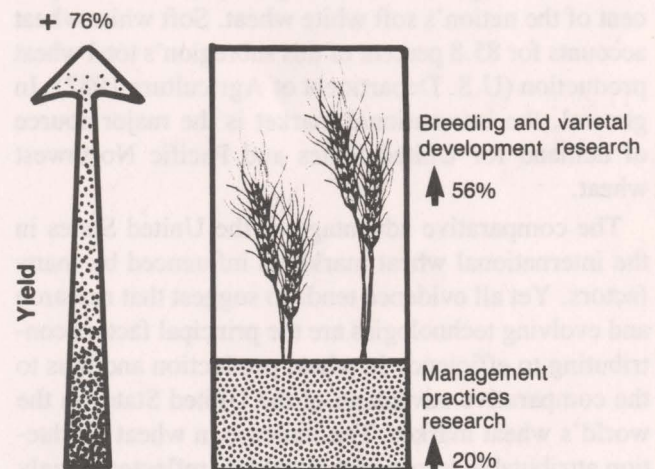


Fig. 1. Wheat yield increases due to public investment in wheat research (western region, 1951-87).

Table 1. Investment in wheat research in the western region, 1987.

States	Total research				Breeding research			
	Federal funds	Nonfederal funds	Total funds	Scientific man years	Federal funds	Nonfederal funds	Total funds	Scientific man years
	(\$)	(\$)	(\$)		(\$)	(\$)	(\$)	
Arizona	39,308	257,418	296,726	1.6	12,038	63,789	75,827	0.4
California	258,087	792,957	1,051,044	3.1	115,479	262,337	377,815	0.3
Colorado	2,088,009	839,295	2,927,302	24.1	1,887,682	558,086	2,445,768	19.6
Idaho	557,032	1,049,577	1,606,609	7.1	28,330	20,254	48,584	0.2
Montana	537,843	1,286,948	1,824,790	10.9	66,748	260,426	327,174	2.0
Nevada	2,570	1,520	4,094	0.0	0	0	0	0.0
New Mexico	2,206	125,774	127,980	0.7	0	8,555	8,555	0.0
Oregon	253,567	912,413	1,165,981	11.6	47,051	309,149	356,200	5.1
Utah	291,366	270,399	561,764	3.7	126,015	133,689	259,704	1.7
Washington	554,267	1,487,657	2,041,924	12.7	87,285	513,160	600,444	2.6
Wyoming	21,322	125,417	146,739	1.0	0	0	0	0.0
Total	4,605,580	7,149,393	11,754,973	76.8	2,370,626	2,129,445	4,500,071	32.0

Source: U.S. Department of Agriculture. 1987. Current Research Information System. Cooperative State Research Service, Washington, D.C.

after the initial investment, with wheat yield peaking at year 5 and declining thereafter. About 78 percent of the effect of breeding research on yield was realized during the first 7 years.

Management practices research influenced wheat yield for 12 years, with peak yield occurring at year 6. About 76 percent of the research impact on yield was realized in the first 8 years.

Total wheat research influenced wheat yield for 12 years with peak yield occurring in the sixth year after the initial investment. About 76 percent of the total research effect on yield was realized in the first 8 years.

## The Benefits of Public Investment In Western Wheat Research

We estimated the benefits of public investment in wheat research in the western region during the 1951-87 period using the number of years that research affected yield (Table 2). The estimated annual rate of return on total public investment was 42 percent. The estimated return on breeding and varietal improvement research was 71 percent and on management practices research was 29 percent (Fig. 2).

### Distribution of Benefits

Producers and consumers of wheat benefit from the increase in wheat production attributable to research. Because a significant proportion of the wheat produced

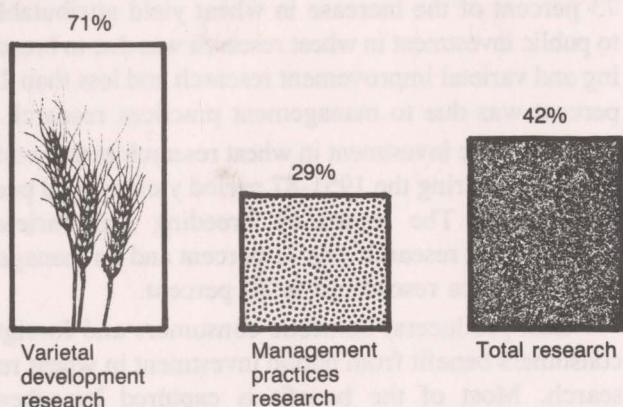


Fig. 2. Annual rate of return to public investment in wheat research (western region, 1951-1987).

in the western region is exported, foreign consumers benefit from wheat research as do domestic producers and consumers. The extent of the benefit to each group depends upon the following factors:

1. Percentage increase in wheat production attributable 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
8. The weighted average price response to changes in wheat production ( $E_D$ ):

$$E_D = E_d \left( \frac{D_d}{D_T} \right) + E_f \left( \frac{D_f}{D_T} \right)$$

We used these factors in an economic model to calculate the benefit of public investment in wheat research to western wheat producers, domestic wheat consumers and international consumers of western wheat.

Economists generally agree that there is a -.2 domestic price response to changes in quantity. In other words, for every 1 percent decrease in the price of wheat, the quantity demanded by domestic consumers will increase by .2 percent.

Several estimates are available for the long-run export price response to quantity changes. They are (1) -6.72 (Johnson 1977), (2) -5.00 (Miller and Washburn 1978, Holland and Sharples 1984), (3) -2.30 (Liu and Roningen 1985) and (4) -1.82 (Paarlberg 1983). For soft white wheat only one price response, -7.4, is available (Taplin 1969).

We used several weighted average price responses to estimate the benefits of research to producers, domestic consumers and foreign consumers. We used a very high price response of -3.88, a high price response of -2.91, a medium price response of -1.38 and a low response of -1.11. For soft white wheat we used only one weighted average price response, -5.29. We used a

Table 2. Estimates of the economic impact of investments in wheat research in the western region, 1951-87.

Research investment	Research expenditures <sup>1</sup>		Increase in yield (%)	Annual rate of return (%)
	Total (\$)	Annual (\$)		
Varietal development	35,483,767	1,043,640	56	71
Management practices	90,385,510	2,658,397	20	29
Total	125,869,277	3,702,037	76	42

<sup>1</sup>Source: U.S. Department of Agriculture. 1967-87. Current Research Information System. Cooperative State Research Service, Washington, D.C. Research expenditures in years before 1967 were obtained from the U.S. Department of Agriculture Agricultural Research Service and the Cooperative State Research Service.

Table 3. The distribution of benefits attributable to public investments in wheat research in the western region, 1951-87.

Price response	Type of research	Distribution of benefit			Total
		Western producers	U.S. consumers	Foreign consumers	
(millions of dollars)					
<b>All wheat</b>					
Very high	Varietal	336.5	38.1	56.2	430.8
	Management	125.5	13.8	19.1	158.4
	All research	448.7	51.6	78.8	579.1
High	Varietal	325.7	49.7	73.0	448.4
	Management	122.4	18.0	24.9	165.3
	All research	432.3	67.3	102.3	601.9
Medium	Varietal	283.8	95.2	137.5	516.5
	Management	110.6	34.4	47.2	192.2
	All research	368.5	129.0	191.8	689.3
Low	Varietal	266.9	133.7	163.1	563.7
	Management	105.8	41.1	56.1	203.0
	All research	343.0	154.2	224.2	721.4
<b>Soft white wheat</b>					
Very high	Varietal	166.8	12.1	37.3	216.2
	Management	65.2	4.4	11.4	81.0
	All research	216.2	16.4	54.9	287.5

wheat supply response of .3, which generally is accepted by economists.

Assuming a high price response, producers benefit relatively more than consumers. The reason is that price drops very little in response to higher wheat production.

Western wheat producers benefit the most from public investment in wheat research (Table 3). Foreign consumers and domestic consumers rank second and third, respectively, in benefits received. Depending on the price response to quantity changes, wheat producers receive between 47 and 77 percent of the benefits attributable to research.

An estimated 75 percent of the total benefits attributable to public investment in wheat research come from breeding and varietal improvement research. Wheat producers receive between 66 and 75 percent of those benefits.

Western producers also are the major beneficiaries of research on soft white wheat. Because such a large share of this product is exported (88.2 percent), the weighted average price is highly responsive to changes in production quantity. As a result of western research on soft white wheat, economic benefits during the 1951-87 period increased \$216.2 million for western

producers, \$16.4 million for U.S. consumers and \$54.9 million for foreign consumers.

### Summary

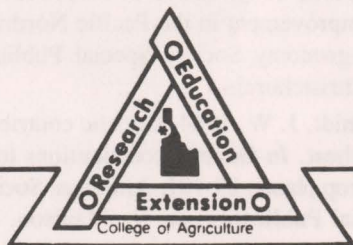
Investment in wheat research during the 1951-87 period increased wheat yield in the western region by 76 percent. Varietal improvement research increased yield by 56 percent, and management practices research increased yield by 20 percent. In other words, more than 73 percent of the increase in wheat yield attributable to public investment in wheat research was due to breeding and varietal improvement research and less than 27 percent was due to management practices research.

Total public investment in wheat research in the western region during the 1951-87 period yielded a 40 percent return. The return on breeding and varietal improvement research was 71 percent and on management practices research was 29 percent.

Wheat producers, domestic consumers and foreign consumers benefit from public investment in wheat research. Most of the benefit is captured by wheat producers, with foreign consumers and domestic consumers ranking second and third, respectively.

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