Reprinted from *1997 Columbia Basin Agricultural Research Annual Report. Spec. Rpt. 977,* pp. 43-46, 1997
Oregon State University in cooperation with USDA-Agricultural Research Service, Pendleton, OR

MAJOR FACTORS INFLUENCING WHEAT YIELD IMPROVEMENT DURING THE LAST THIRTY YEARS

William A. Payne, Paul E. Rasmussen
and Roger Goller

INTRODUCTION

Long-term experiments maintained at the Columbia Basin Agricultural Research Center provide invaluable information on historical trends in crop production, yield stability, sustainability of cropping systems, and crop response to climate. Analyses of historical data allow scientists to make predictions for the future, and to draw conclusions on the viability and soundness of various aspects of cropping systems.

We have begun analyses of thirty years' yield data from five long-term experiments. The purpose of this report is to present preliminary conclusions on major factors influencing wheat yield during the last thirty years, and to make tentative predictions on their future viability. The factors discussed in this report are new varieties, N fertilizer addition, fallowing to maintain yield stability in winter and spring wheat cropping systems, and precipitation.

MATERIALS AND METHODS

Yield and precipitation data were taken from five long-term experiments for the years 1967 to 1996. The experimental treatments selected for these analyses were:

1. Wheat/fallow rotation, using improved varieties and the old Kharkov variety from annual variety testing trials;
2. Wheat/fallow rotation, using modern winter wheat varieties with and without N fertilizer addition, from long-term crop residue trials;
3. Wheat/pea rotation, with N fertilizer addition;
4. Continuous winter wheat, with fertilizer addition;
5. Continuous spring wheat, with fertilizer addition; and

Wheat/fallow rotation with spring wheat and fertilizer addition.

Yield and precipitation data were plotted against time for all years. Simple linear regression was used to characterize long-term trends for yield and stability trends.

RESULTS AND DISCUSSION

Winter (Sep 1 - Mar 31) precipitation was highly variable from year to year (Figure 1).

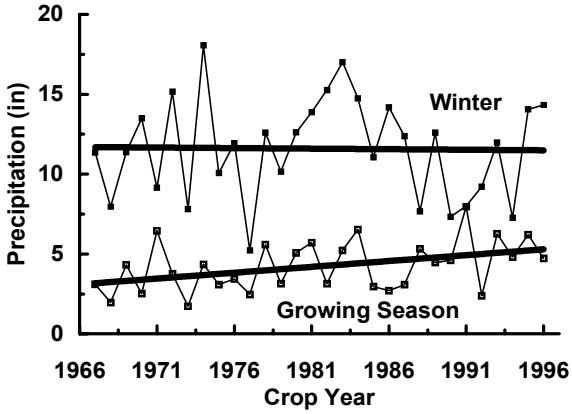

Figure 1. Winter (Sep 1 - Mar 31) and growing season (Apr 1 - Jun 30) precipitation at the Pendleton research center from 1967 to 1996.

There were successive wet years in the early eighties, and successive dry years in the early nineties, but there were no apparent long-term trends. More sophisticated analyses and larger data sets would be required to identify any periodic tendencies in winter rainfall patterns.

Growing season (Apr 1 - Jun 30) precipitation, on the other hand, has tended to increase slightly since 1967 (Figure 1), with an average increase of 0.07 inches per year. Whether this is a truly sustained trend or simply part of a short to medium term cycle would have profound consequences for cropping system strategies.

Yield data allow us to make qualitative inferences about the influence that improved varieties, fertilizer addition, fallowing, and precipitation have had on long-term yield trends in the different cropping systems.

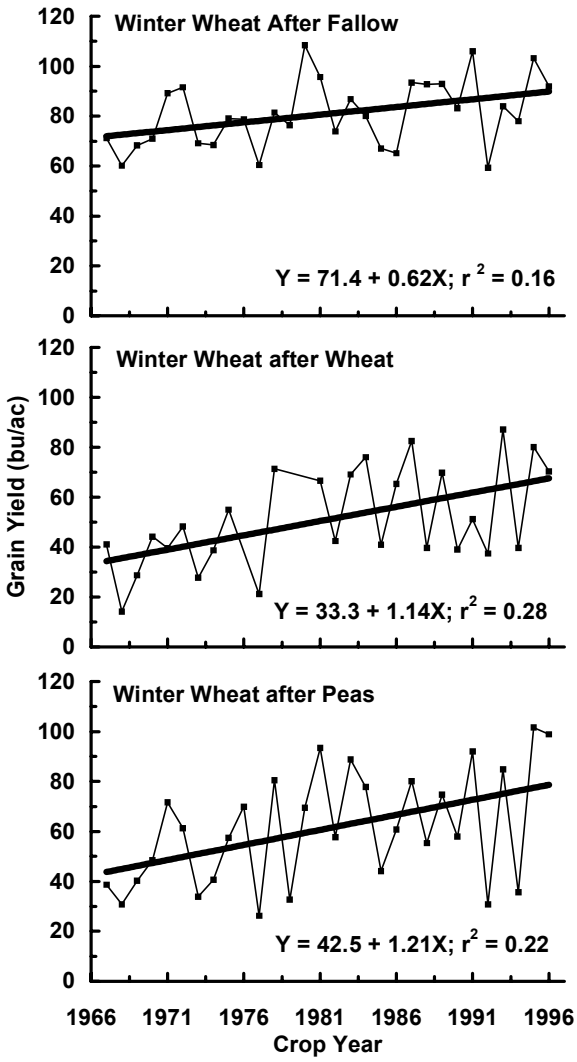

Figure 2. Long-term yield trends at the Pendleton research center from 1967 to 1996 for three N-fertilized winter wheat cropping systems.

Winter wheat yields in the wheat/fallow rotations were erratic, but generally increased during the 30 year period (Figure 2). This increase averaged more than 0.6 bushels per year for plots where improved varieties were grown with N fertilizer (Figure 3). Data from the annual variety trials suggest that part of this increase is dependent upon the use of

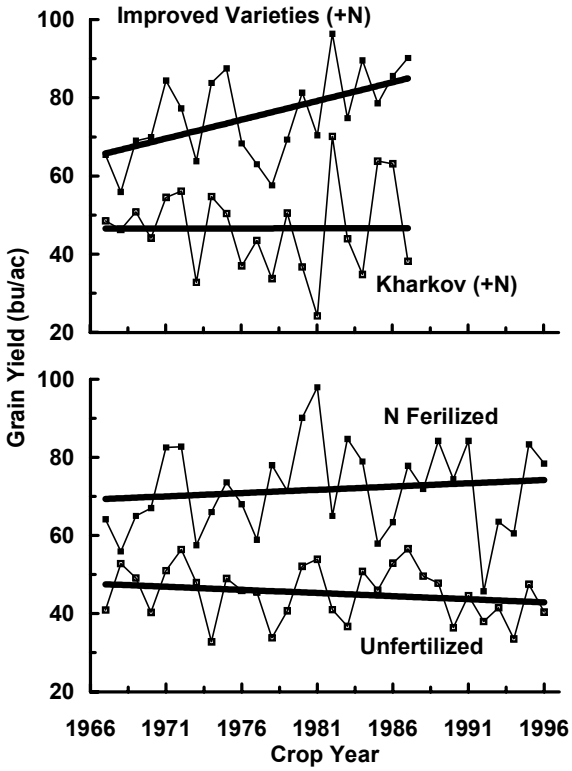

Figure 3. Long-term yield trends due to improved varieties and N fertilization at the Pendleton research station from 1967 to 1996.

improved varieties that have the ability to respond to favorable weather conditions. Average yield of the best varieties has gradually increased, whereas yield of the discontinued Kharkov variety has shown no

increase despite generally increasing rainfall during the growing season (Figure 1).

The role of N fertilizer in increasing winter wheat yield can be clearly seen in Figure 3. Yields of unfertilized plots were remarkably stable (but low) compared to fertilized plots. Unfertilized plots have gradually declining yields, presumably due to depletion of soil fertility. This illustrates the importance of having sufficient soil fertility to allow the wheat crop to take full advantage of additional soil moisture in favorable rainfall years.

Winter wheat yields have also increased when grown annually or in rotation with peas (Figure 2). Average yearly yield increase is 1.2 bushels/acre in annual cropping compared to 0.6 for winter wheat following fallow. However, the data show clearly that annual cropping greatly decreased yield stability of winter wheat, because of the absence of fallow to stabilize crop water supply. For example, from 1994 to 1995, winter wheat yield varied from 30 to 100 bushels in the wheat/pea rotations, and from about 35 to 75 bushels in the continuous wheat plots, but only from 70 to 90 bushels in the wheat/fallow system. These data serve to point out why risk management must be a major consideration when annual cropping winter wheat.

Overall, the effect of fallowing upon stabilizing yield was less apparent for spring wheat when compared to annual cropping (Figure 4). There were, however, some very dry years, such as 1992, during which fallowing helped maintain yields compared to annual cropping. Spring wheat yield in both annual and fallowed systems has been steadily increasing over the past 30 years. The similar yield stability of annual spring wheat compared to wheat/fallow rotation, combined with the trend of yield gains, suggest that annual spring wheat is an increasingly attractive cropping system for growing conditions similar to ours. However, our analysis suggests that increased yield has been associated with increased growing season rainfall (Figure 1).

Under present rainfall patterns, spring cropping has the potential to compete more favorably with winter wheat than was the case 20 to 30 years ago. An added advantage of spring cropping is that it provides opportunities for better control of grassy weeds such as downy brome, wild oats, and goatgrass.

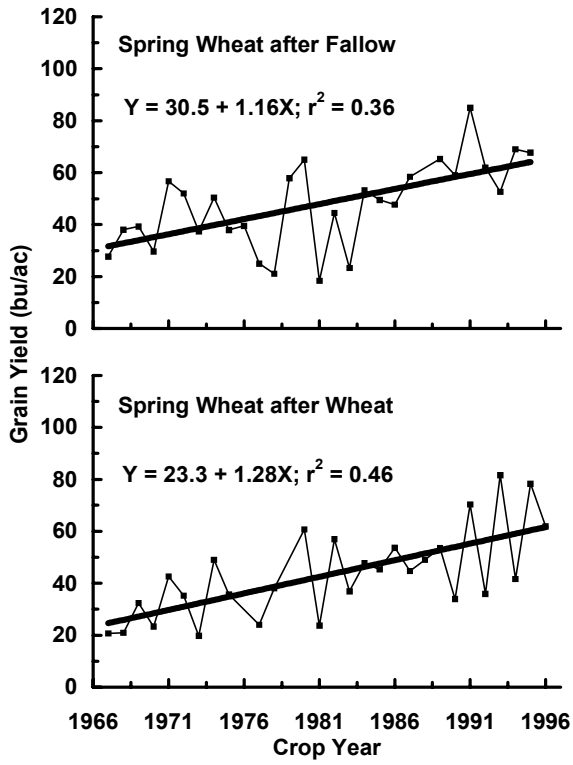

Figure 4. Long-term yield trends for two spring wheat cropping systems receiving adequate N-fertilizer additions at the Pendleton research center from 1967 to 1996.

A primary drawback to spring cropping, however, remains the difficulty of seeding large areas because of too few sufficiently dry days for cultivation, seeding, etc.

Obviously, a return to drier spring weather, such as was seen in 1992 or 1994, would render spring cropping much less attractive.